LineUp With Math™

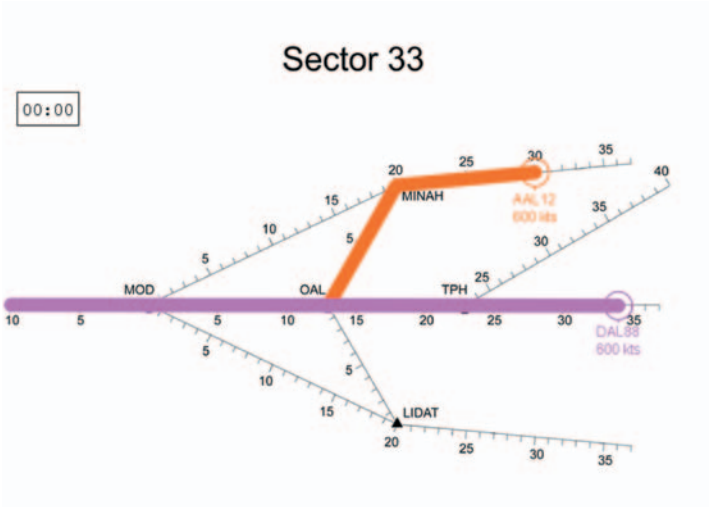
Air Traffic Control Simulator

Solutions and Answers to Problems

Problem 2-1

Solution

Starting Conditions:



Plane	From	Through	To	Distance	Speed
AAL12	MINAH	OAL	MOD	33	600
DAL88	TPH	OAL	MOD	34	600

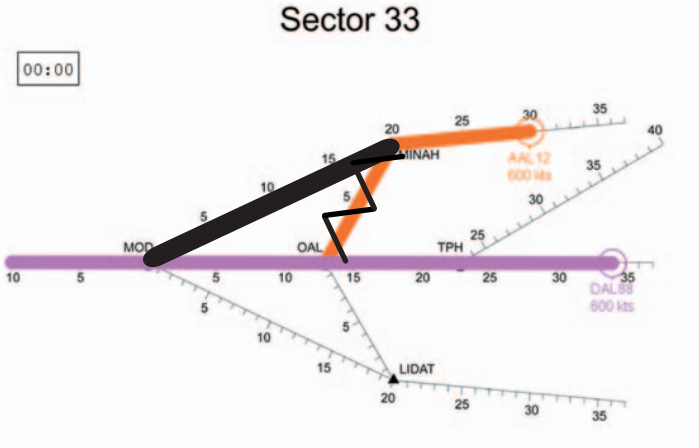
- Ideal spacing at **MOD** - 3 Nmiles

Analysis:

- **Conflict: DAL88** will arrive at OAL **1 Nmile** behind **AAL12.**
- **AAL12** can take the shortcut to shorten its distance of travel by 3 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	AAL12	33	1
2nd	DAL88	34	

Solution:



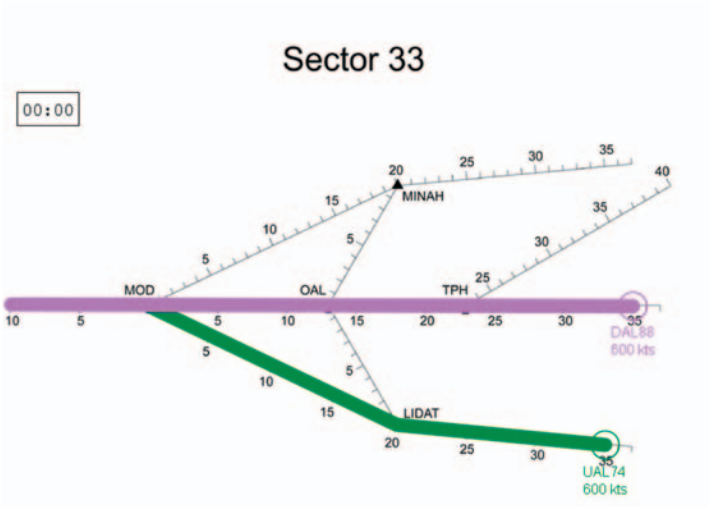
- **AAL12 -** Reroute direct to MOD to move forward 3 Nmiles. Spacing at MOD is 4 Nmiles. This is greater than 3 Nmiles Ideal Spacing.

- **Target Time** - 3:24 mins.

Problem 2-2

Solution

Starting Conditions:



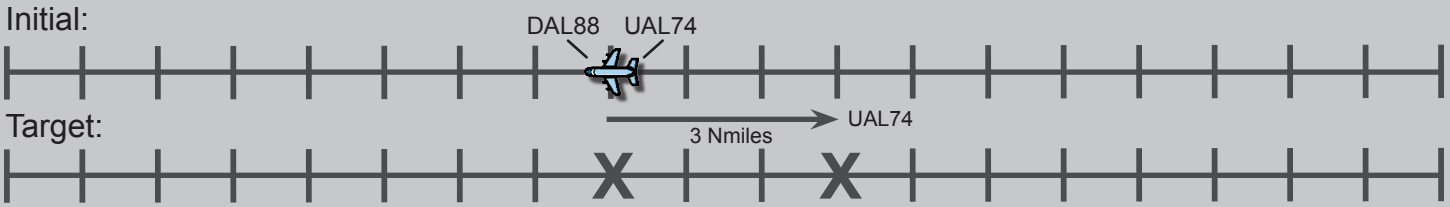
Plane	From	Through	To	Distance	Speed
DAL88	TPH	OAL	MOD	35	600
UAL74	LIDAT		MOD	35	600

- Ideal spacing at **MOD** - 3 Nmiles

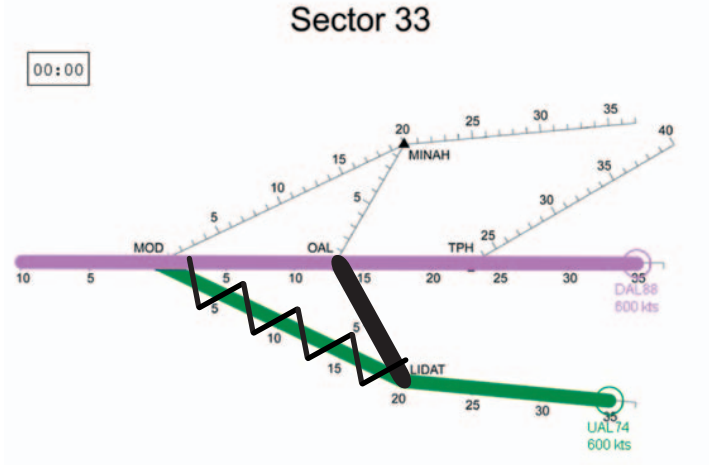
Analysis:

- **Conflict: DAL88 AND UAL74** will arrive at MOD at the same time.
- **UAL74** can take the long route through OAL to extend its travel distance by 3 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	DAL88	35	0
2nd	UAL74	35	



Solution:

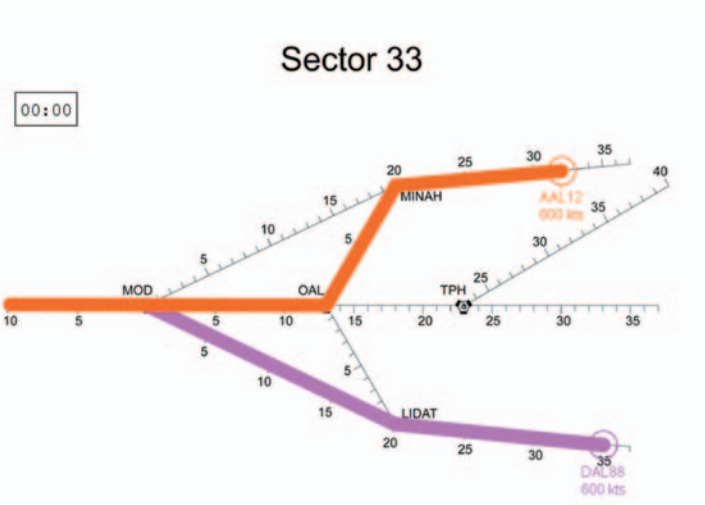


- **UAL74 -** Reroute through OAL to fall back 3 Nmiles.
- **Target Time** - 3:48 mins.

Problem 2-3

Solution

Starting Conditions:



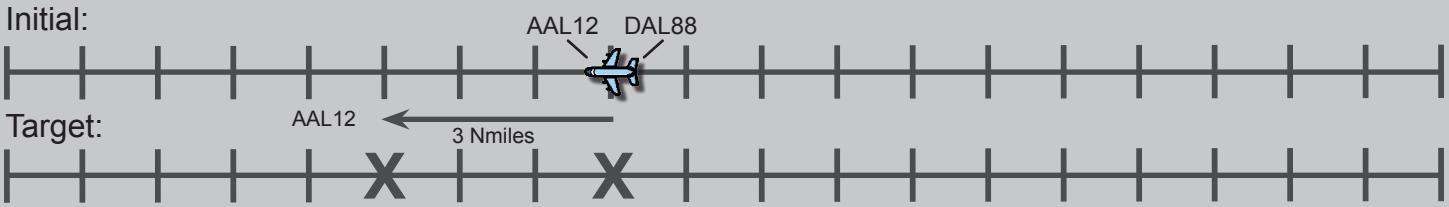
Plane	From	Through	To	Distance	Speed
AAL12	MINAH	OAL	MOD	35	600
DAL88	LIDAT		MOD	35	600

- Ideal spacing at **MOD** - 3 Nmiles

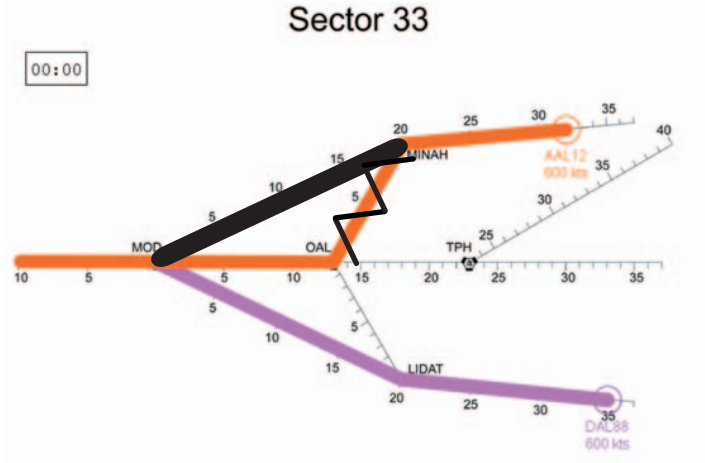
Analysis:

- **Conflict: DAL88 AND AAL12** will arrive at MOD at the same time.
- **AAL12** can take the shortcut to shorten its travel distance by 3 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	AAL12	35	0
1st	DAL88	35	



Solution:

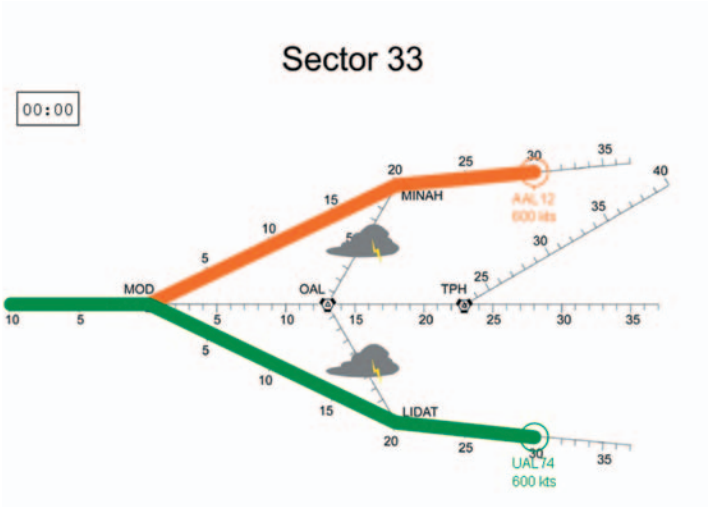


- **AAL12 -** Reroute direct to MOD to move forward 3 Nmiles.
- **Target Time** - 3:30 mins.

Problem 2-4

Solution

Starting Conditions:



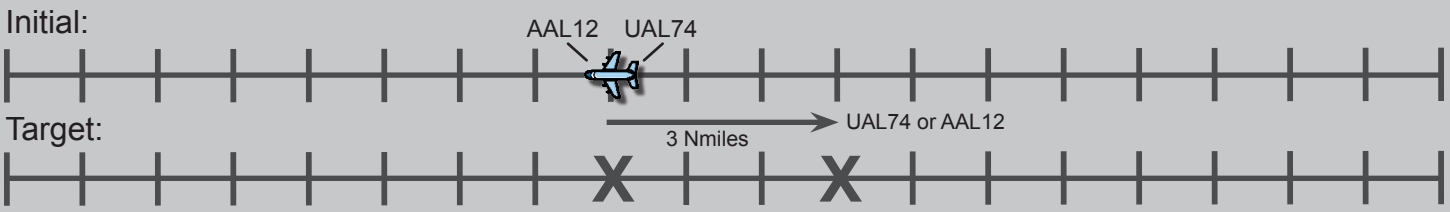
Plane	From	Through	To	Distance	Speed
AAL12	MINAH		MOD	30	600
UAL74	LIDAT		MOD	30	600

- Route from **LIDAT** to **OAL is closed**.
- Route from **MINAH** to **OAL is closed.**
- Ideal spacing at **MOD** - 3 Nmiles

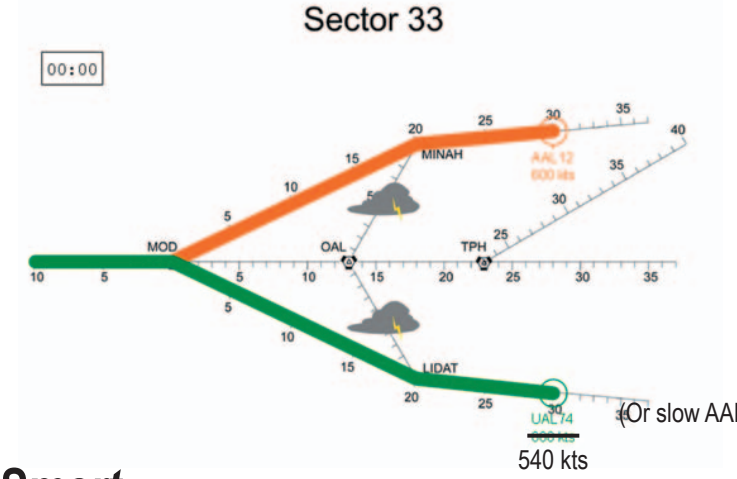
Analysis:

- **Conflict: AAL12 AND UAL74** will arrive at MOD at the same time.
- **Weather** prevents **AAL12** or **UAL74** from rerouting.
- **UAL74** or **AAL12** need to slow down to fall back 3 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	AAL12	30	0
1st	UAL74	30	



Solution:



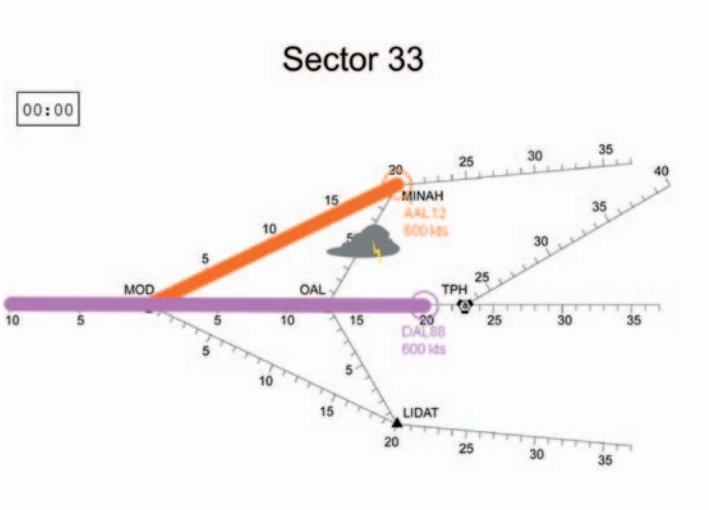
- **UAL74 or AAL12 -** Slow down to 540 knots for 3 minutes to fall back 3 Nmiles. Then speed up to 600 knots.
- **Target Time** - 3:18 mins.

(Or slow AAL12 to 540 kts.)

Problem 2-5

Solution

Starting Conditions:



Plane	From	Through	To	Distance	Speed
AAL12	LIDAT		MOD	20	600
DAL88	OAL		MOD	20	600

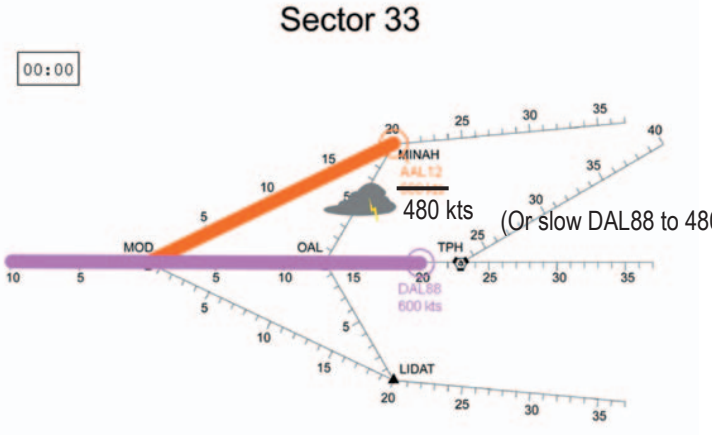
- Route from **MINAH** to **OAL is closed**
- Ideal spacing at **MOD** - 3 Nmiles

Analysis:

- **Conflict: DAL88 AND AAL12** will arrive at MOD at the same time.
- Weather prevents AAL12 from rerouting.
- **AAL74** or **DAL88** need to slow down to fall back 3 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	DAL88	20	0
1st	AAL12	20	

Solution:



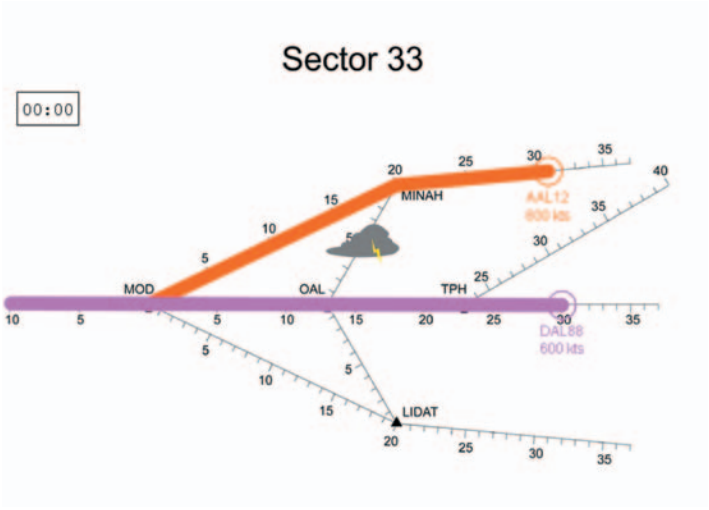
- **AAL12 or DAL88 -** Slow down to 480 knots for 1.5 minutes to fall back 3 Nmiles. Then speed up to 600 knots.
  Note: Slowing to 540 knots would only result in falling back 2 Nmiles in the 20 Nmiles to MOD.

- **Target Time** - 2:18 mins.

Problem 2-6

Solution

Starting Conditions:



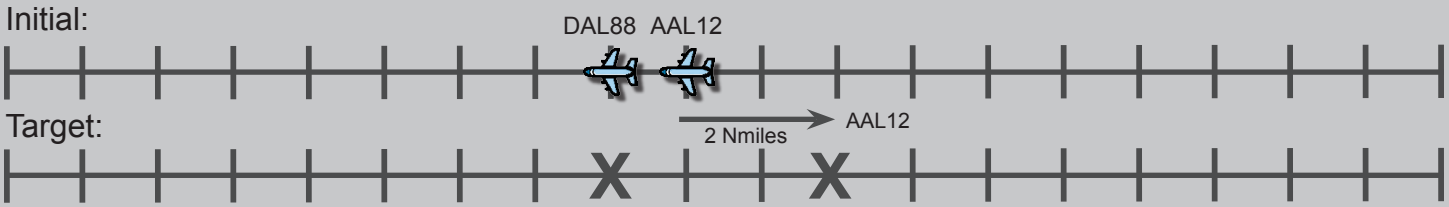
Plane	From	Through	To	Distance	Speed
AAL12	MINAH		MOD	31	600
DAL88	TPH	OAL	MOD	30	600

- Route from **MINAH** to **OAL is closed**.
- Ideal spacing at **MOD** - 3 Nmiles

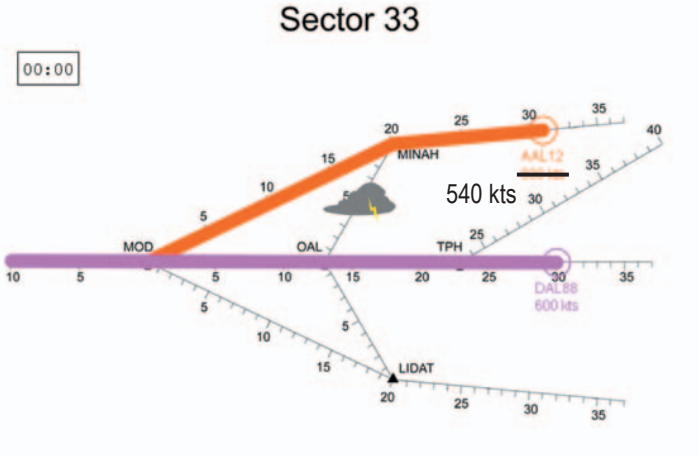
Analysis:

- **Conflict: AAL12** will arrive at MOD **1 Nmile** behind **DAL88.**
- **Weather** prevents **AAL12** from rerouting.
- **AAL12** needs to slow down to fall back 2 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	DAL88	30	1
2nd	AAL12	31	



Solution:

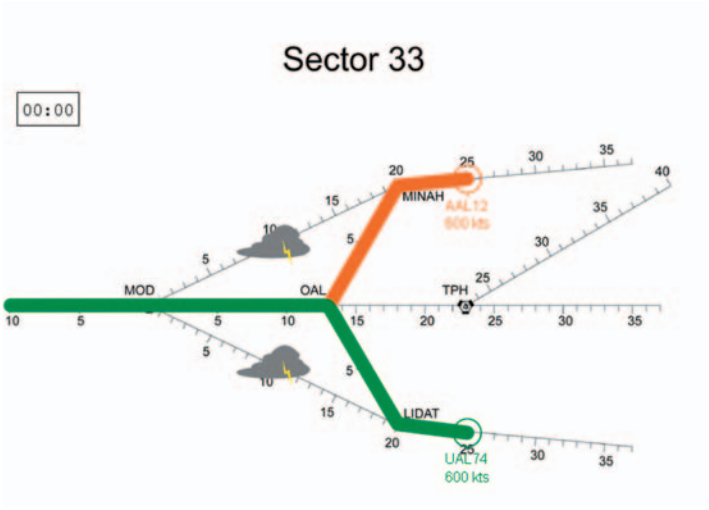


- **AAL12 -** Slow down to 540 knots for 2 minutes to fall back 2 Nmiles. Then speed up to 600 knots.
- **Target Time** - 3:18 mins.

Problem 2-7

Solution

Starting Conditions:



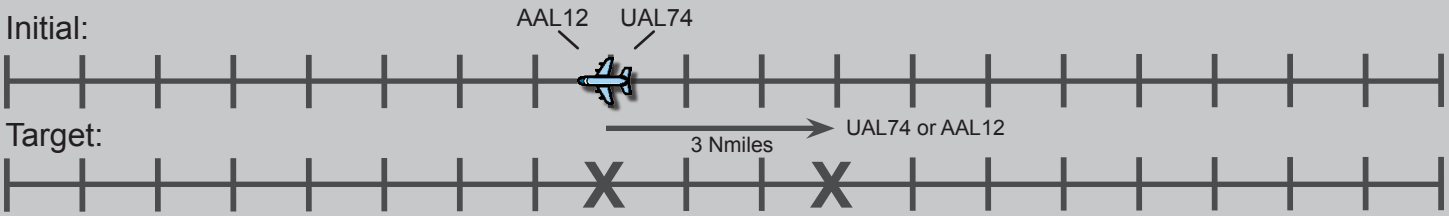
Plane	From	Through	To	Distance	Speed
AAL12	MINAH	OAL	MOD	28	600
UAL74	LIDAT	OAL	MOD	28	600

- Route from **MINAH** to **MOD is closed**.
- Route from **LIDAT** to **MOD is closed**.
- Ideal spacing at **MOD** - 3 Nmiles

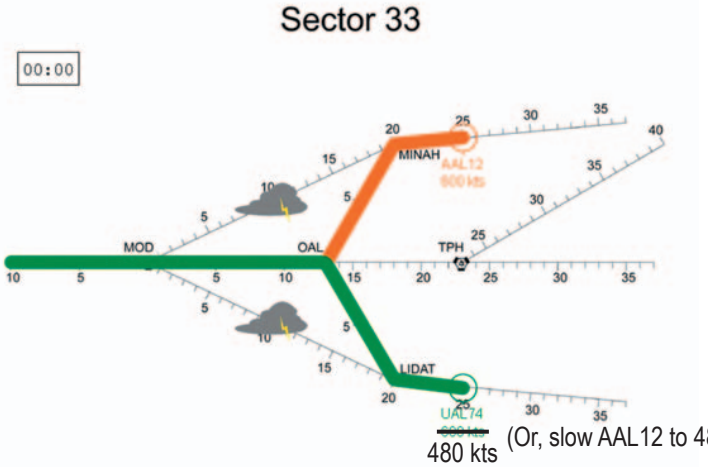
Analysis:

- **Conflict: AAL12 AND UAL74** will arrive at OAL at the same time.
- **Weather** prevents **AAL12 AND UAL74** from rerouting.
- **UAL74** or **AAL12** need to slow down to fall back 2 Nmiles by OAL **and** 3 Nmiles by MOD.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	AAL12	28	0
1st	UAL74	28	



Solution:



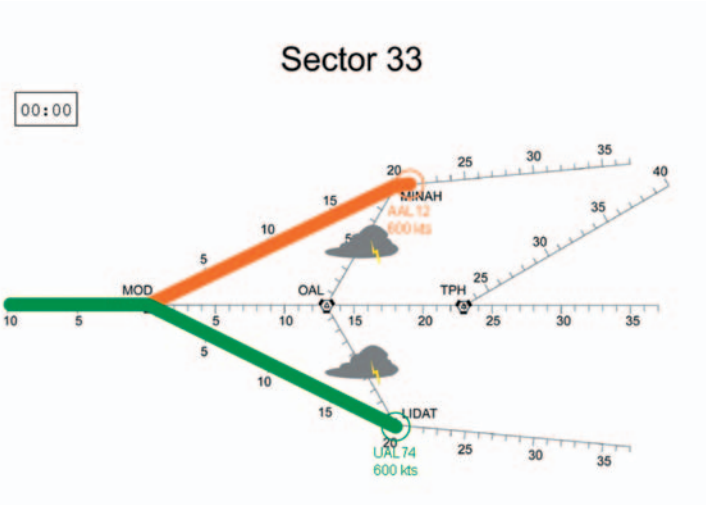
(Or, slow AAL12 to 480 kts.)

- **UAL74 or AAL12 -** Slow down to 480 knots for 1.5 minutes to fall back 3 Nmiles **at OAL**. Then speed up to 600 knots.
- **Target Time** - 3:06 mins.

Problem 2-8

Solution

Starting Conditions:



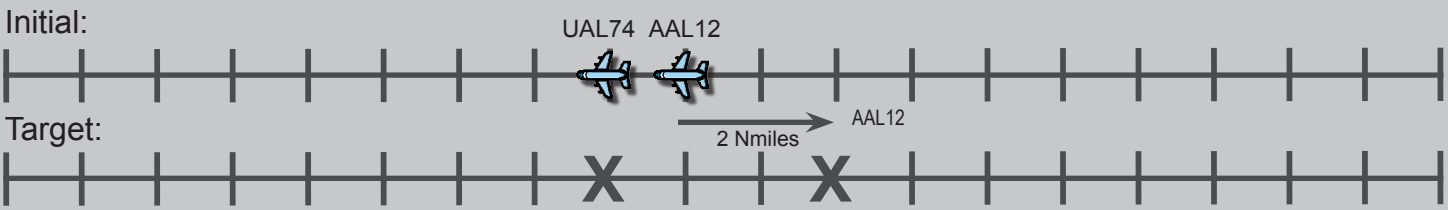
Plane	From	Through	To	Distance	Speed
AAL12	MINAH		MOD	21	600
UAL74	LIDAT		MOD	20	600

- Route from **LIDAT** to **OAL is closed**.
- Route from **MINAH** to **OAL is closed**.
- Ideal spacing at **MOD** - 3 Nmiles

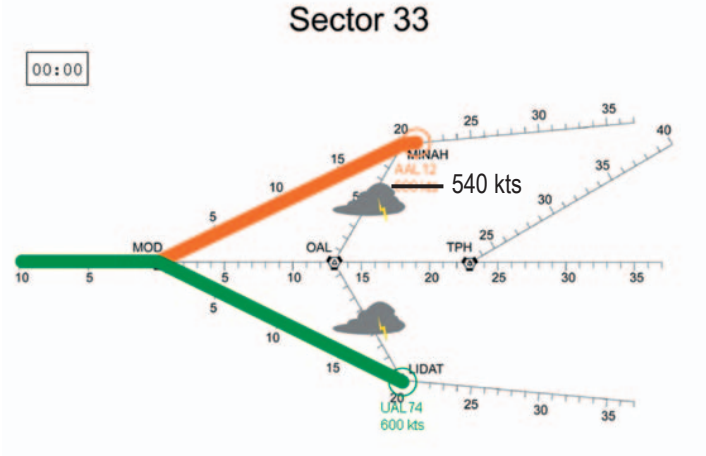
Analysis:

- **Conflict: AAL12** will arrive at MOD **1 Nmile** behind **UAL74**.
- **Weather** prevents UAL74 or AAL12 from rerouting.
- **AAL12** needs to slow down to fall back 2 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	UAL74	20	1
2nd	AAL12	21	



Solution:

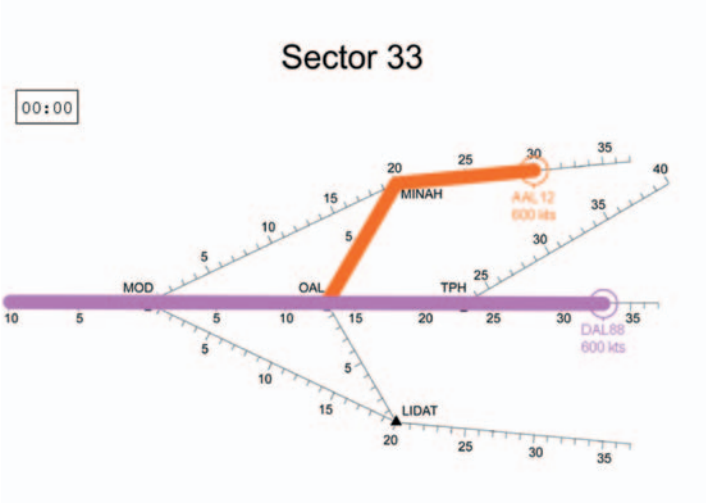


- **AAL12 -** Slow down to 540 knots for 2 minutes to fall back 2 Nmiles. Then speed AAL12 up to 600 knots.
- **Target Time** - 2:18 mins.

Problem 2-9

Solution

Starting Conditions:



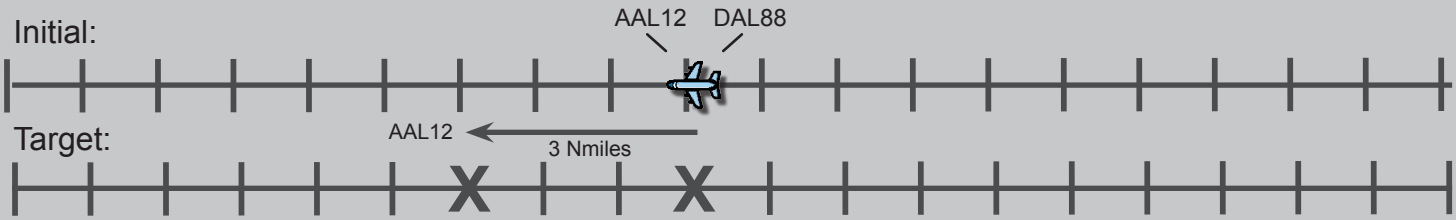
Plane	From	Through	To	Distance	Speed
AAL12	MINAH	OAL	MOD	33	600
DAL88	TPH	OAL	MOD	33	600

- Ideal spacing at **MOD** - 3 Nmiles

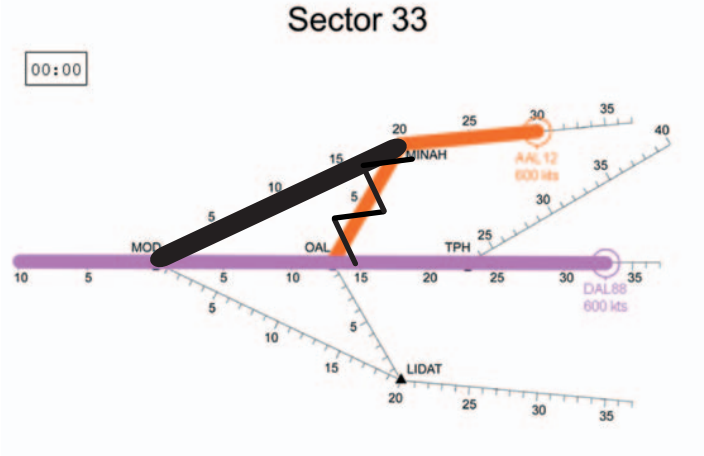
Analysis:

- **Conflict: AAL12 AND DAL88** will arrive at OAL at the same time.
- Send **AAL12** on the shortcut to shorten its travel distance by 3 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	AAL12	33	0
1st	DAL88	33	



Solution:

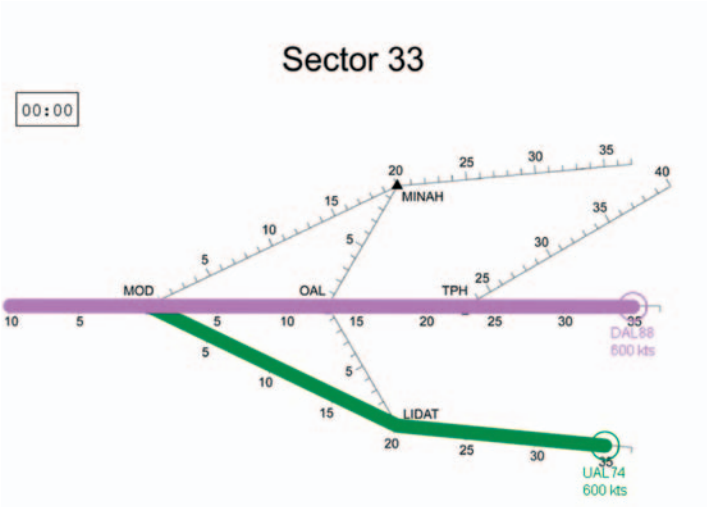


- **AAL12 -** Reroute direct to MOD to move forward by 3 Nmiles.
- **Target Time** - 3:18 mins.

Problem 2-10

Solution

Starting Conditions:



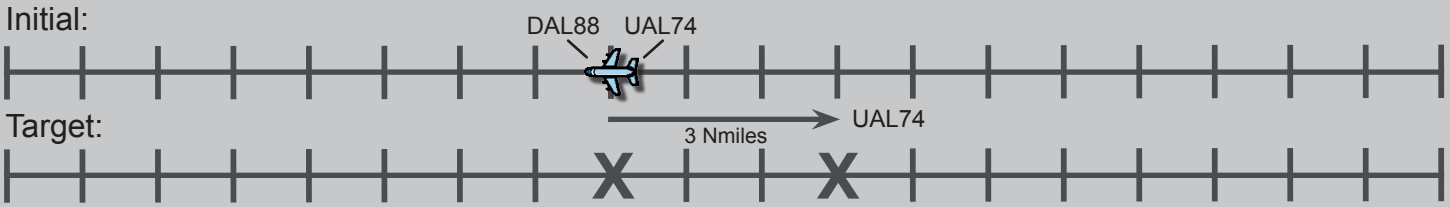
Plane	From	Through	To	Distance	Speed
DAL88	TPH	OAL	MOD	35	600
UAL74	LIDAT		MOD	35	600

- Ideal spacing at **MOD** - 3 Nmiles

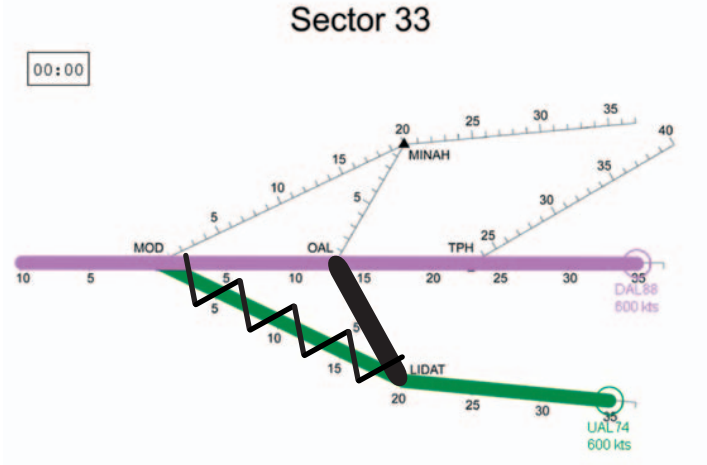
Analysis:

- **Conflict: DAL88 AND UAL74** will arrive at MOD at the same time.
- **UAL74** can take the long route through OAL to lengthen its travel distance by 3 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	DAL88	35	0
1st	UAL74	35	



Solution:

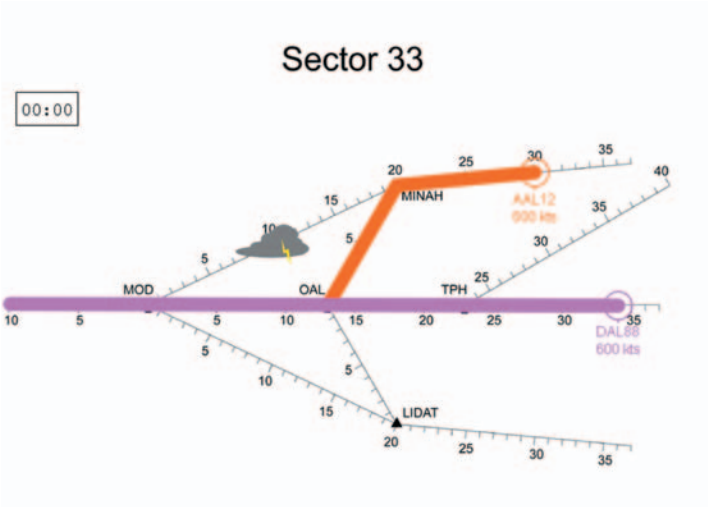


- **UAL74 -** Reroute through OAL to fall back by 3 Nmiles.
- **Target Time** - 3:48 mins.

Problem 2-11

Solution

Starting Conditions:



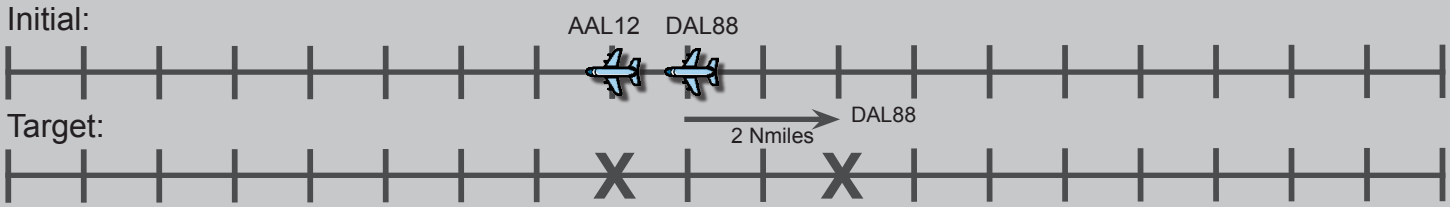
Plane	From	Through	To	Distance	Speed
AAL12	MINAH	OAL	MOD	33	600
DAL88	TPH	OAL	MOD	34	600

- Route from **MINAH** to **MOD is closed**
- Ideal spacing at **MOD** - 3 Nmiles

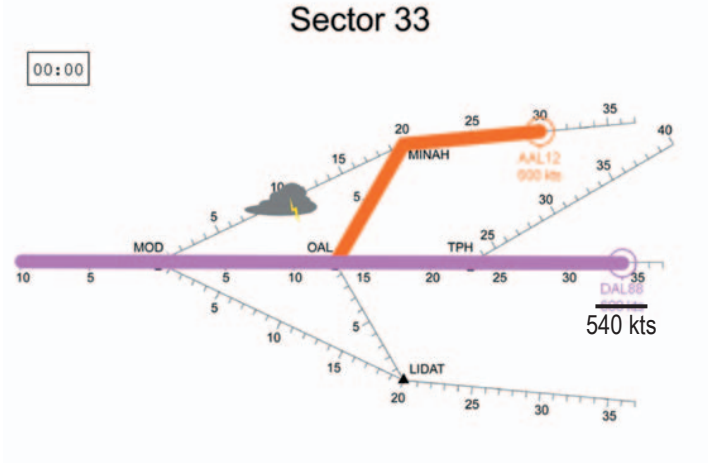
Analysis:

- **Conflict:** **DAL88** will arrive at OAL **1 Nmile** behind **AAL12**.
- **Weather** prevents **AAL12** from rerouting.
- **DAL88** needs to slow down to fall back 2 Nmiles by **MOD** (and at least 1 Nmile by OAL).

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	AAL12	33	1
2nd	DAL88	34	



Solution:

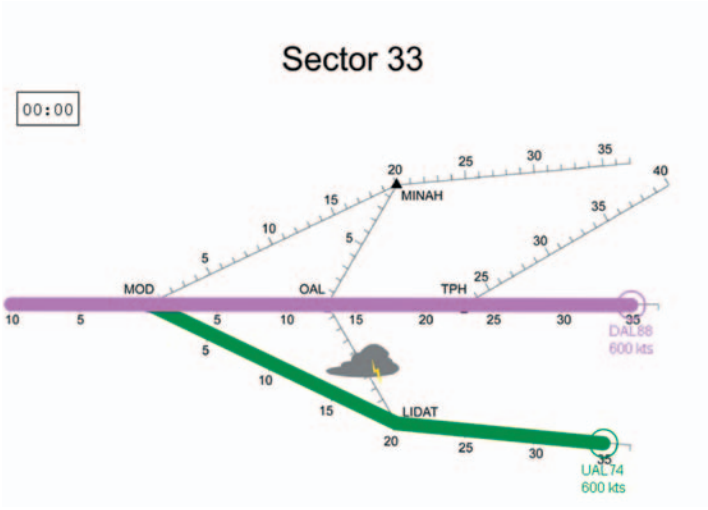


- **DAL88 -** Slow down to 540 knots for 2 minutes to fall back 2 Nmiles. Then speed up to 600 knots.
- **Target Time** - 3:36 mins.

Problem 2-12

Solution

Starting Conditions:



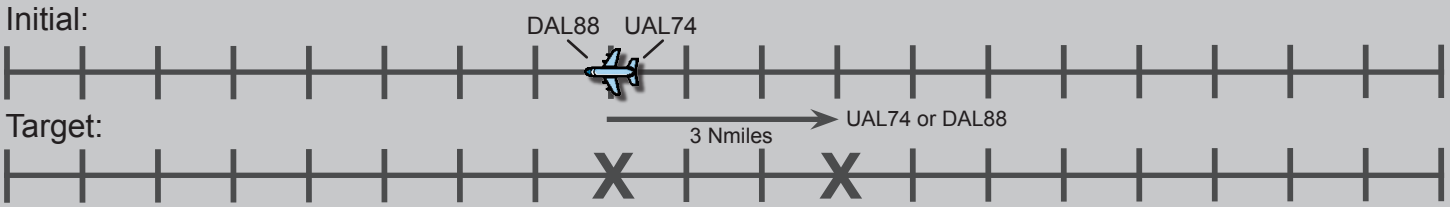
Plane	From	Through	To	Distance	Speed
DAL88	TPH	OAL	MOD	35	600
UAL74	LIDAT		MOD	35	600

- Route from **LIDAT** to **OAL is closed**.
- Ideal spacing at **MOD** - 3 Nmiles

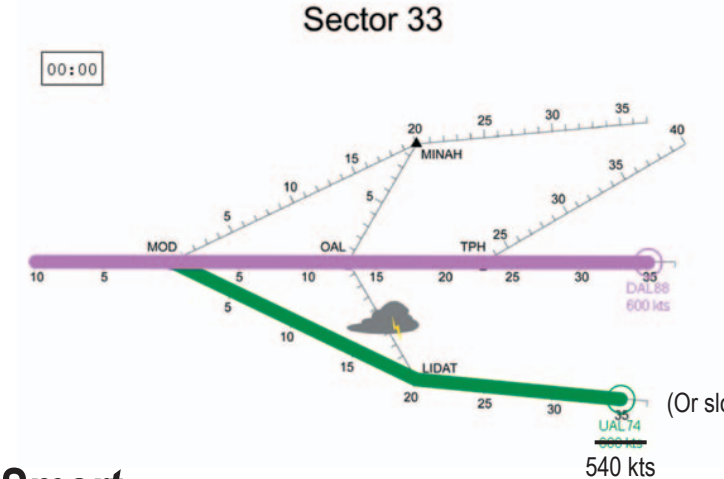
Analysis:

- **Conflict:** **DAL88** **AND** **UAL74** will arrive at MOD at the same time.
- **Weather** prevents **UAL74** from rerouting.
- **UAL74** or **DAL88** need to slow down to fall back 3 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	DAL88	35	0
1st	UAL74	35	



Solution:



- **UAL74 or DAL88 -** Slow down to 540 knots for 3 minutes to fall back 3 Nmiles. Then speed up to 600 knots.

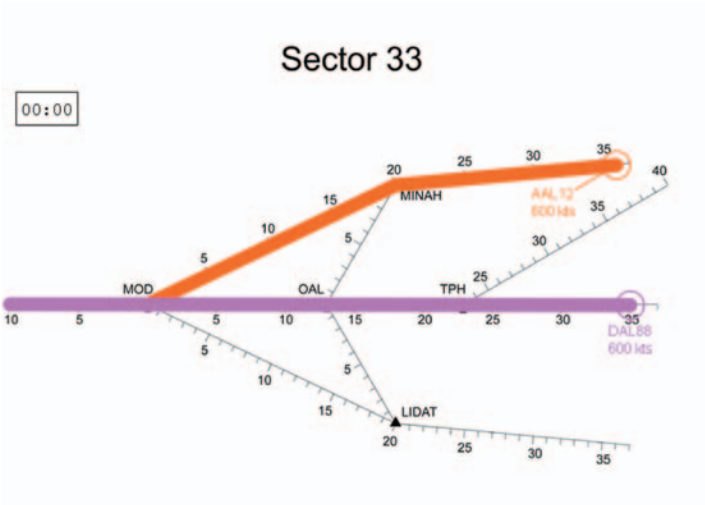
- **Target Time** - 3:48 mins.

(Or slow DAL88 to 540 kts.)

Problem 2-13

Solution

Starting Conditions:



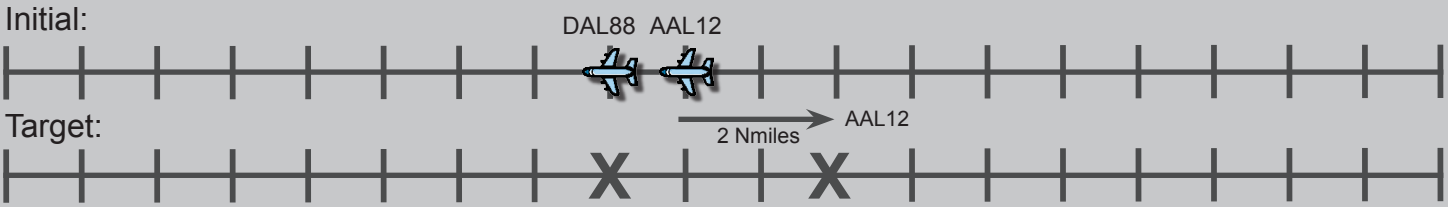
Plane	From	Through	To	Distance	Speed
AAL12	MINAH		MOD	36	600
DAL88	TPH	OAL	MOD	35	600

- Ideal spacing at **MOD** - 3 Nmiles

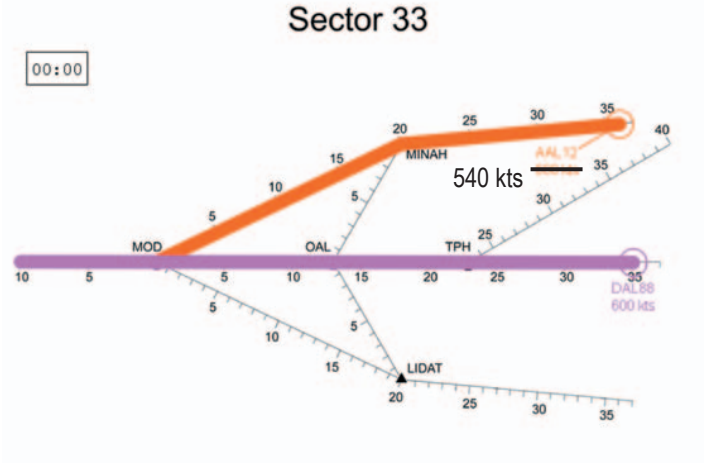
Analysis:

- **Conflict: AAL12** will arrive at MOD **1 Nmile** behind **DAL88.**
- **AAL12** needs to slow down to fall back 2 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	DAL88	35	1
2nd	AAL12	36	



Solution:

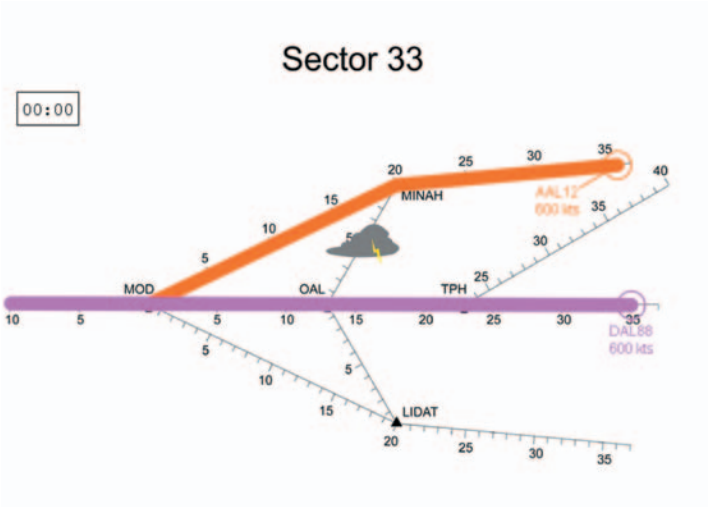


- **AAL12 -** Slow down to 540 knots for 2 minutes to fall back 2 Nmiles. Then speed up to 600 knots.
- **Target Time** - 3:48 mins.

Problem 2-14

Solution

Starting Conditions:



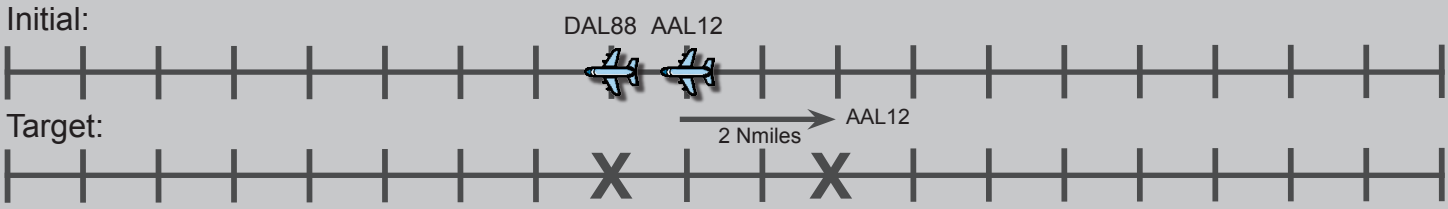
Plane	From	Through	To	Distance	Speed
AAL12	MINAH		MOD	36	600
DAL88	TPH	OAL	MOD	35	600

- Route from **MINAH** to **OAL** is closed.
- Ideal spacing at **MOD** - 3 Nmiles

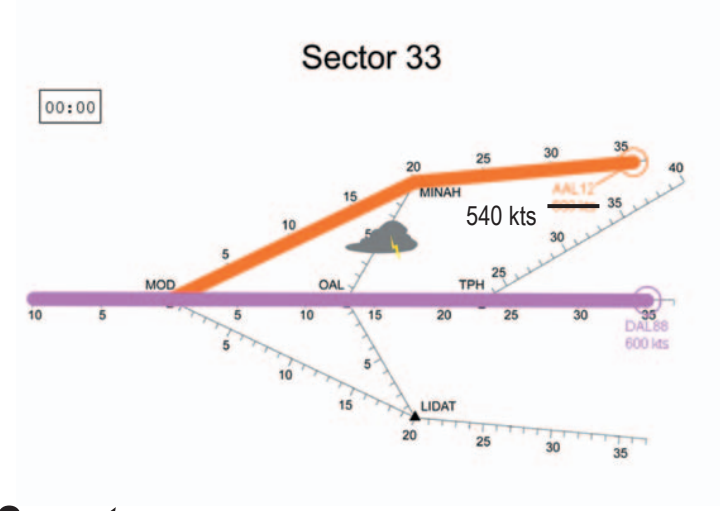
Analysis:

- **Conflict: AAL12** will arrive at MOD **1 Nmile** behind **DAL88.**
- **Weather** prevents **AAL12** from rerouting.
- **AAL12** needs to slow down to fall back 2 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	DAL88	35	1
2nd	AAL12	36	



Solution:

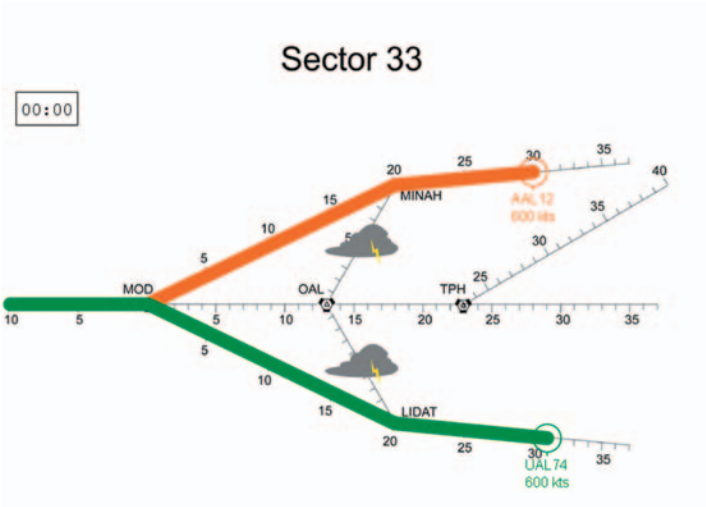


- **AAL12 -** Slow down to 540 knots for 2 minutes to fall back 2 Nmiles. Then speed up to 600 knots.
- **Target Time** - 3:48 mins.

Problem 2-15

Solution

Starting Conditions:



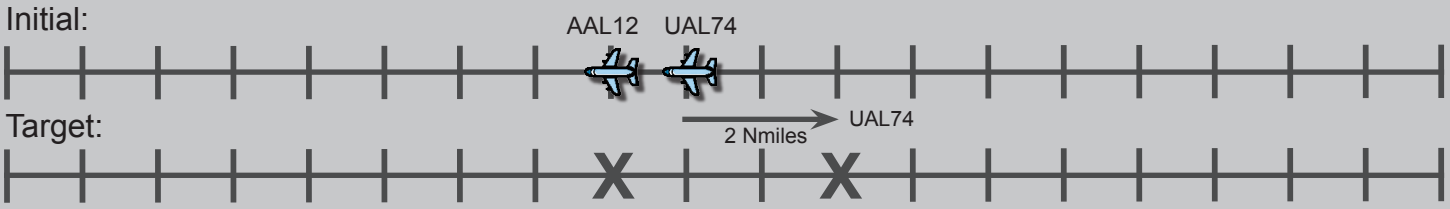
Plane	From	Through	To	Distance	Speed
AAL12	MINAH		MOD	30	600
UAL74	LIDAT		MOD	31	600

- Route from **LIDAT** to **OAL is closed**.
- Route from **MINAH** to **OAL is closed.**
- Ideal spacing at **MOD** - 3 Nmiles

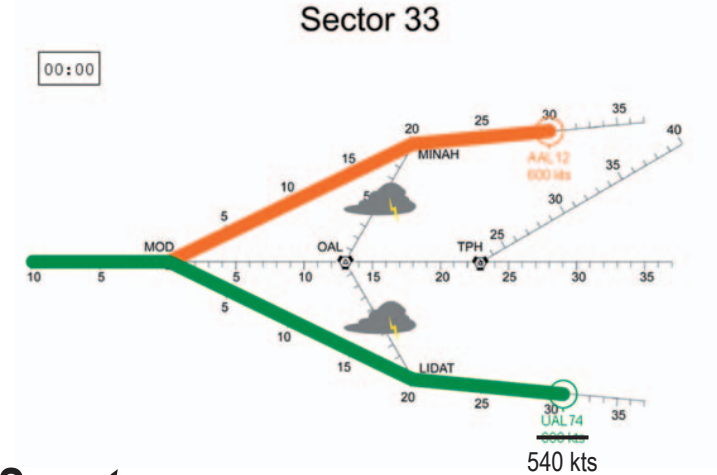
Analysis:

- **Conflict:** **UAL74** will arrive at MOD **1 Nmile** behind **AAL12**.
- **Weather** prevents **UAL74** or **AAL12** from rerouting.
- **UAL74** needs to slow down to fall back 2 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	AAL12	30	1
2nd	UAL74	31	



Solution:



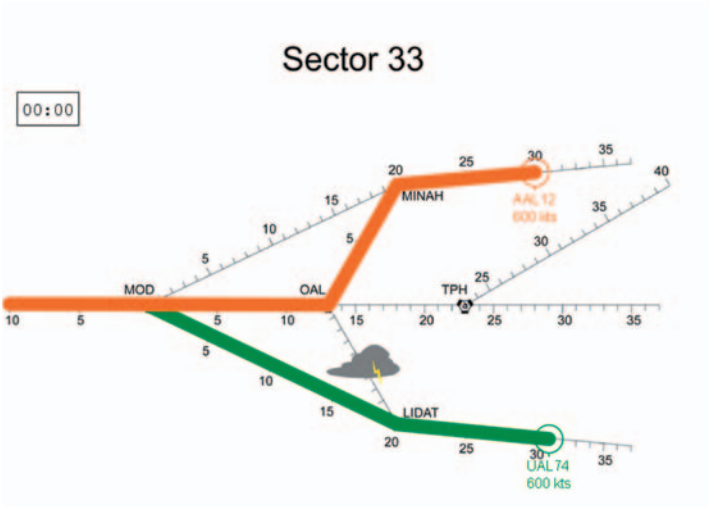
540 kts

- **UAL74 -** Slow down to 540 knots for 2 minutes to fall back 2 Nmiles. Then speed up to 600 knots.
- **Target Time** - 3:18 mins.

Problem 2-16

Solution

Starting Conditions:



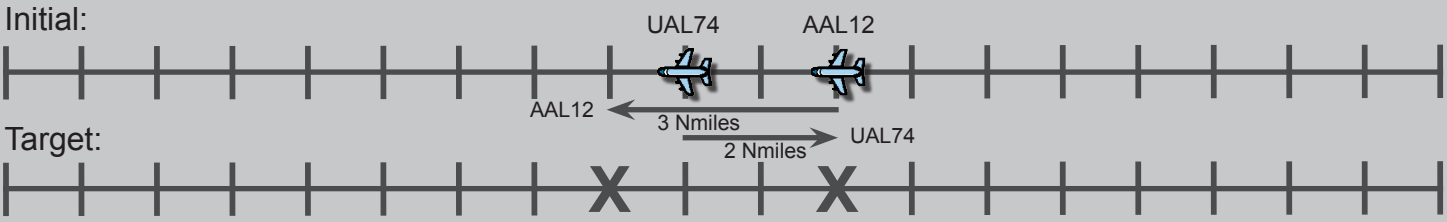
Plane	From	Through	To	Distance	Speed
AAL12	MINAH	OAL	MOD	33	600
UAL74	LIDAT		MOD	31	600

- Route from **LIDAT** to **OAL is closed**.
- Ideal spacing at **MOD** - 3 Nmiles

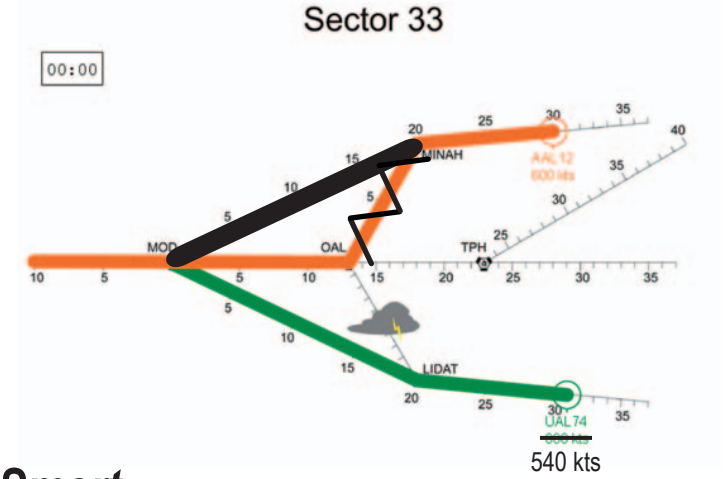
Analysis:

- **AAL12** will arrive at MOD **2 Nmiles** behind **UAL74**.
- **Weather** prevents UAL74 from rerouting
- **AAL12** can take the shortcut to shorten its travel distance by 3 Nmiles and move ahead of **UAL74** by 1 Nmile. **UAL74** can slow down to fall back 2 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	UAL74	31	2
2nd	AAL12	33	



Solution:



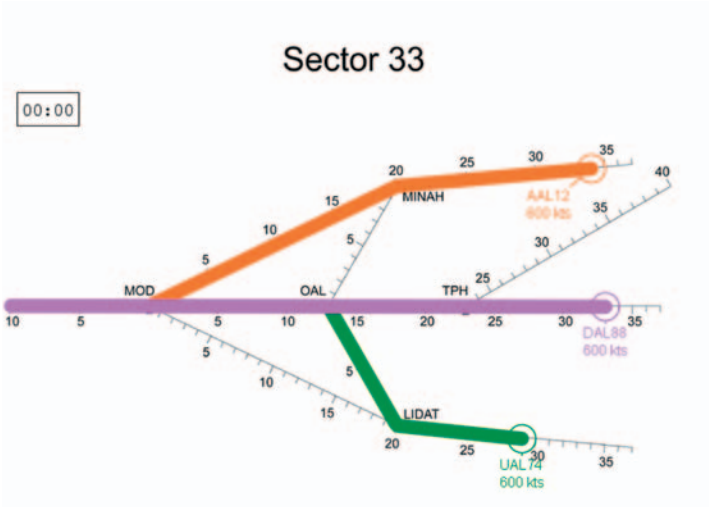
- **AAL12 -** Send direct MOD to move forward 3 Nmiles.
- **UAL74 -** Slow down to 540 knots for 2 minutes to fall back 2 Nmiles. Then speed up to 600 knots.

- **Target Time** - 3:18 mins.

Problem 3-1

Solution

Starting Conditions:



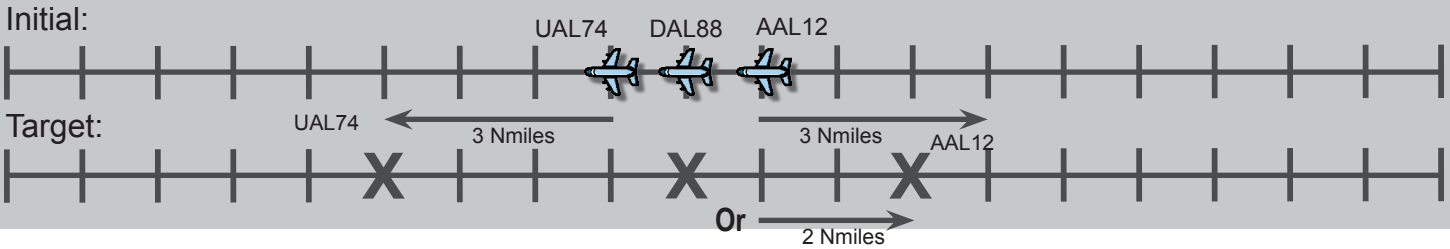
Plane	From	Through	To	Distance	Speed
AAL12	MINAH		MOD	34	600
DAL88	TPH	OAL	MOD	33	600
UAL74	LIDAT	OAL	MOD	32	600

- Ideal spacing at **MOD** - 3 Nmiles

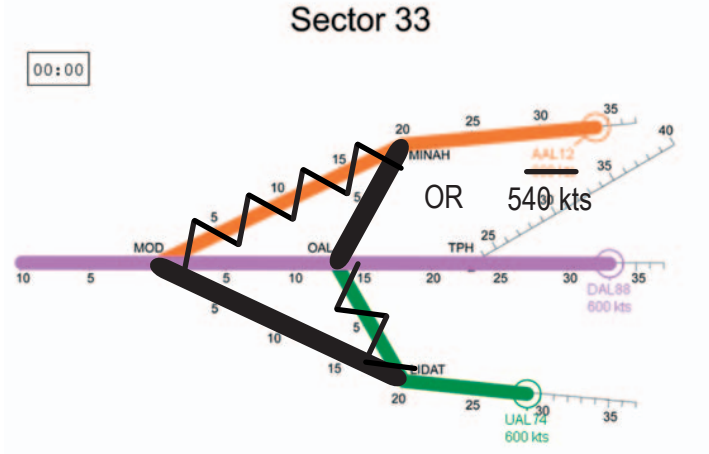
Analysis:

- **Conflict: UAL74, DAL88 and AAL12** will arrive at MOD at each with 1 Nmile separation.
- **UAL74** can take the shortcut to shorten its travel distance. **AAL12** can go through OAL to lengthen its travel distance by 3 Nmiles. (or slow down to fall back 2 Nmiles - best solution)

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	UAL74	32	1
2nd	DAL88	33	1
3rd	AAL12	34	



Solution:



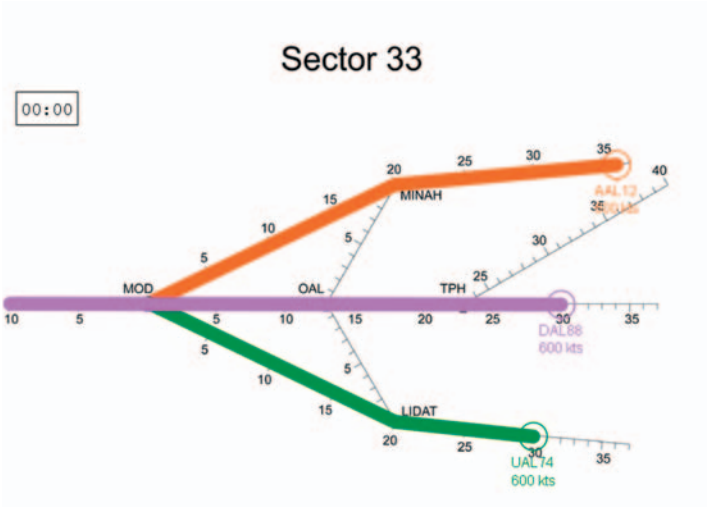
- **UAL74 -** Reroute direct MOD to move forward 3 Nmiles
- **AAL12 -** Reroute through OAL to fall back 3 Nmiles
  (**Or**, slow to 540 kts for 2 mins to fall back 2 Nmiles)

- **Target Time** - 3:42 mins. (route changes only)
  - 3:36 mins. (route and speed change)

Problem 3-2

Solution

Starting Conditions:



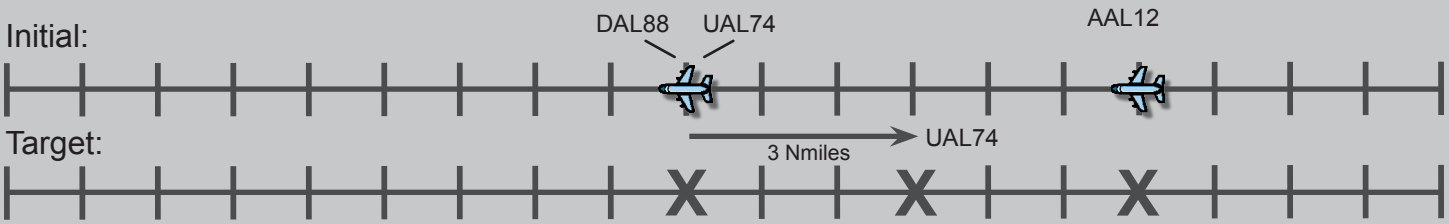
Plane	From	Through	To	Distance	Speed
AAL12	MINAH		MOD	36	600
DAL88	TPH	OAL	MOD	30	600
UAL74	LIDAT		MOD	30	600

- Ideal spacing at **MOD** - 3 Nmiles

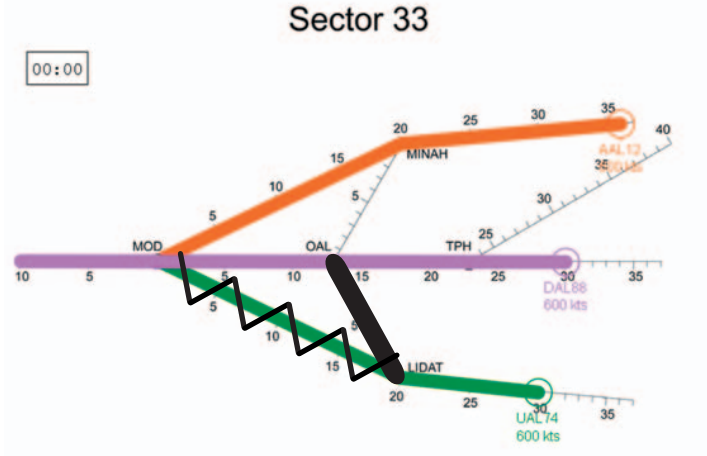
Analysis:

- **Conflict: UAL74 AND DAL 88** will arrive at MOD at the same time.
- **AAL12** will be **6 Nmiles** behind.
- **UAL74** can go through OAL to lengthen its travel distance by 3 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	UAL74	30	0
1st	DAL88	30	
2nd	AAL12	36	6



Solution:

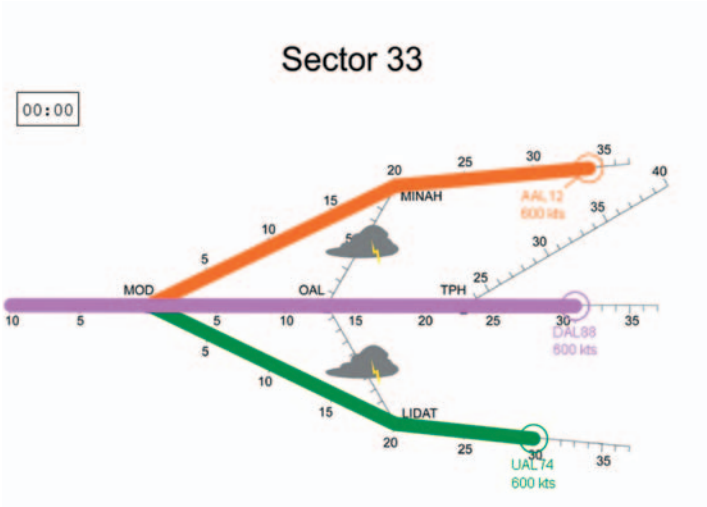


- **UAL74 -** Reroute through OAL to fall back 3 Nmiles.
- **Target Time** - 3:36 mins.

Problem 3-3

Solution

Starting Conditions:



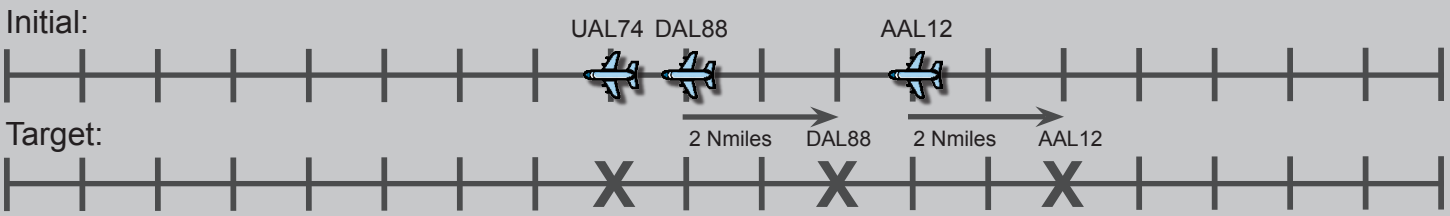
Plane	From	Through	To	Distance	Speed
AAL12	MINAH		MOD	34	600
DAL88	TPH	OAL	MOD	31	600
UAL74	LIDAT		MOD	30	600

- Route from **MINAH** to **OAL is closed**.
- Route from **LIDAT** to **OAL is closed**.
- Ideal spacing at **MOD** - 3 Nmiles

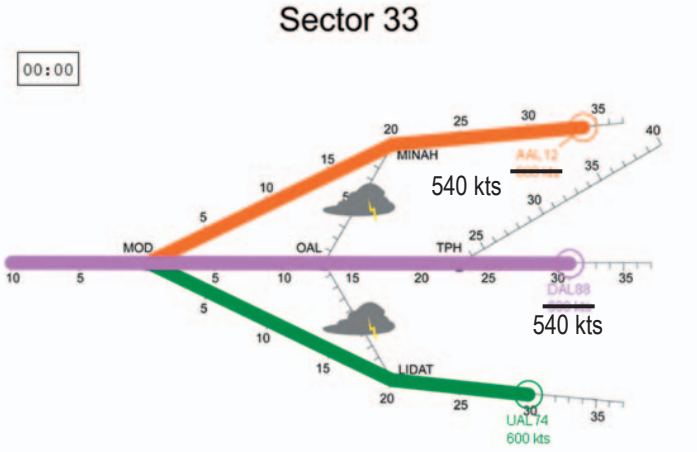
Analysis:

- **Conflict:** **DAL88** will arrive at MOD **1 Nmile** behind **UAL74**.
- **Weather** prevents **UAL74 AND AAL12** from rerouting.
- **DAL88** can slow down to fall back 2 Nmiles. **AAL12** will then need to slow down to fall back 2 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	UAL74	30	1
2nd	DAL88	31	3
3rd	AAL12	34	



Solution:



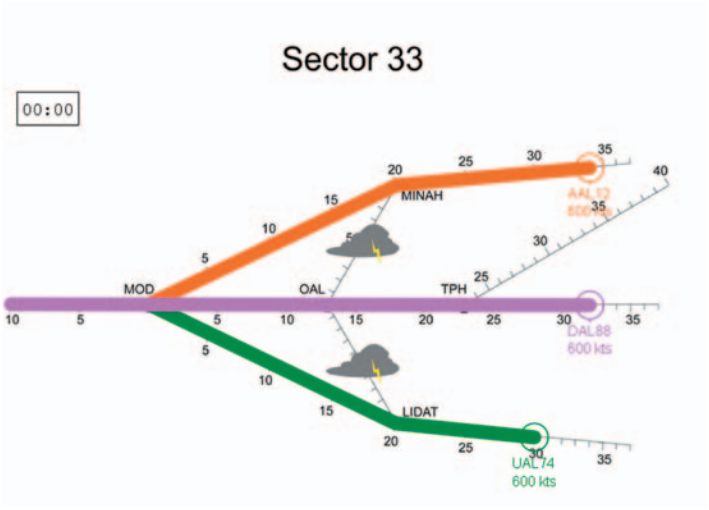
- **AAL12 -** Slow down to 540 knots for 2 minutes to fall back 2 Nmiles. Then speed up to 600 knots.
- **DAL88 -** Slow down to 540 knots for 2 minutes to fall back 2 Nmiles. Then speed up to 600kts.

- **Target Time** - 3:36 mins.

Problem 3-4

Solution

Starting Conditions:



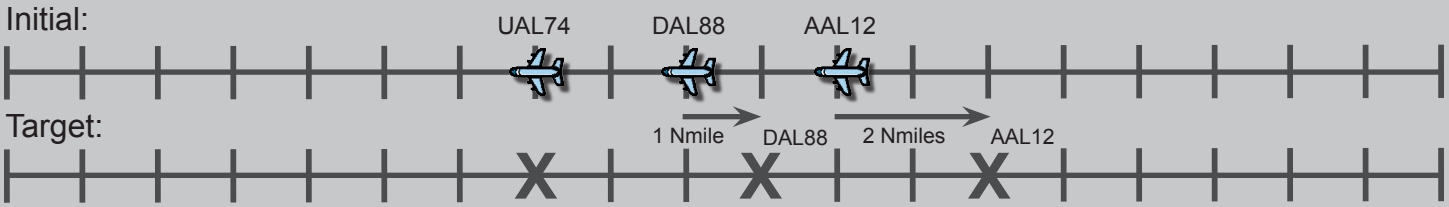
Plane	From	Through	To	Distance	Speed
AAL12	MINAH		MOD	34	600
DAL88	TPH	OAL	MOD	32	600
UAL74	LIDAT		MOD	30	600

- Route from **LIDAT** to **OAL is closed**.
- Route from **MINAH** to **OAL is closed**.
- Ideal spacing at **MOD** - 3 Nmiles

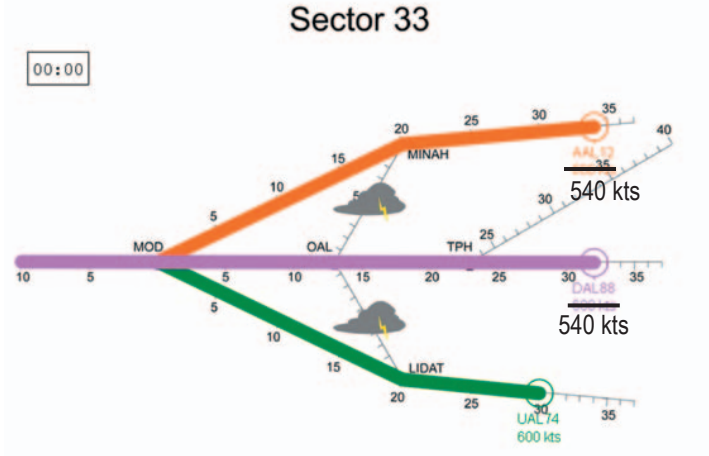
Analysis:

- **UAL74 AND DAL88** will arrive at MOD 2 Nmiles apart.
  AAL12 AND DAL88 will arrive at MOD 2 Nmiles apart.
- **Weather** prevents **UAL74 AND AAL12** from rerouting.
- **DAL88 AND AAL12** both need to slow down to fall back 1 and 2 Nmiles, respectively.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	UAL74	30	→ 2
2nd	DAL88	32	→ 2
3rd	AAL12	34	



Solution:



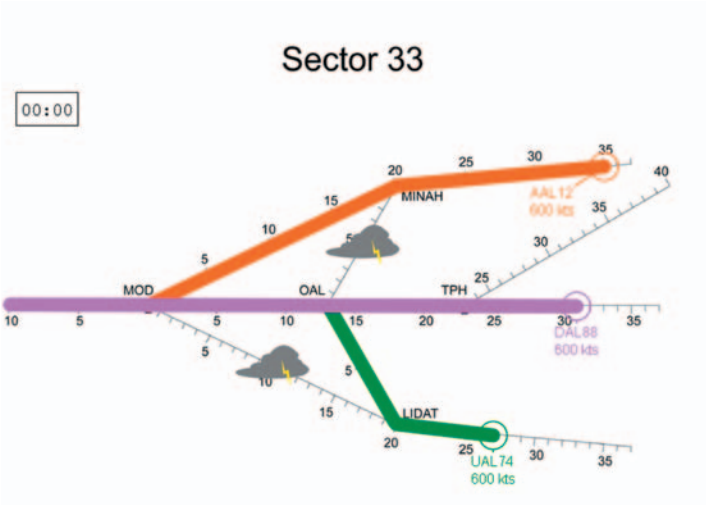
- **DAL88 -** Slow down to 540 knots for 1 minute to fall back 1 Nmile. Then speed up to 600 knots.
- **AAL12 -** Slow down to 540 knots for 2 minutes to fall back 2 Nmiles. Then speed up to 600 knots.

- **Target Time** - 3:36 mins.

Problem 3-5

Solution

Starting Conditions:



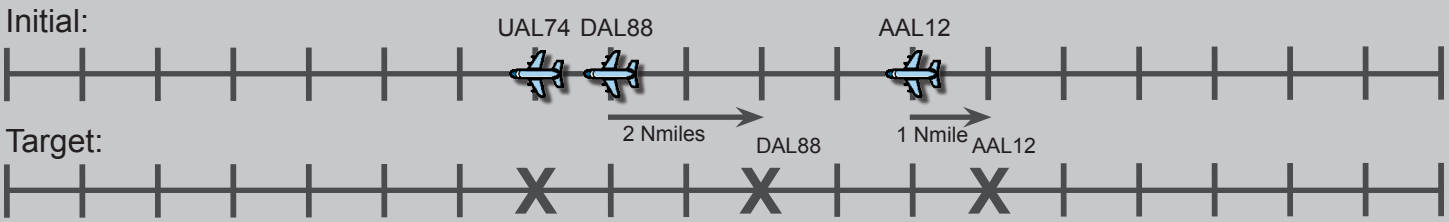
Plane	From	Through	To	Distance	Speed
AAL12	MINAH		MOD	35	600
DAL88	TPH	OAL	MOD	31	600
UAL74	LIDAT	OAL	MOD	30	600

- Route from **MINAH** to **OAL is closed.**
- Route from **LIDAT** to **MOD is closed.**
- Ideal spacing at **MOD** - 3 Nmiles

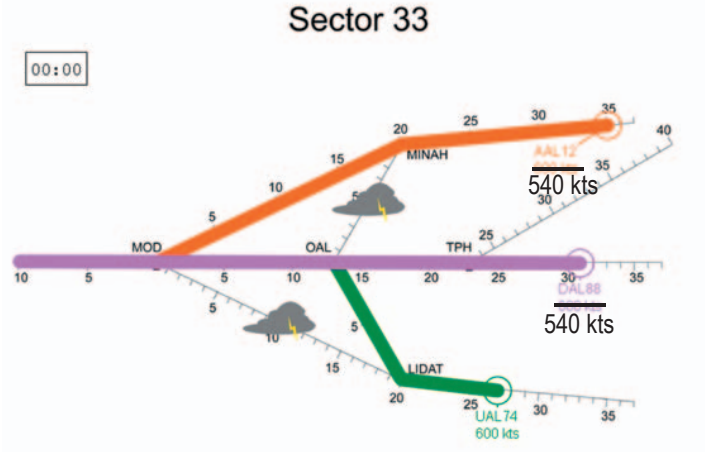
Analysis:

- **Conflict:** **DAL88** will arrive at OAL **1 Nmile** behind **UAL74.**
- **Weather** prevents **AAL12 AND UAL74** from rerouting.
- **DAL88** needs to slow down to fall back 2 Nmiles (at least 1 Nmile before **OAL**).
- **AAL12** needs to slow to fall back 1 Nmile before **OAL**.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	UAL74	30	1
2nd	DAL88	31	4
3rd	AAL12	35	



Solution:



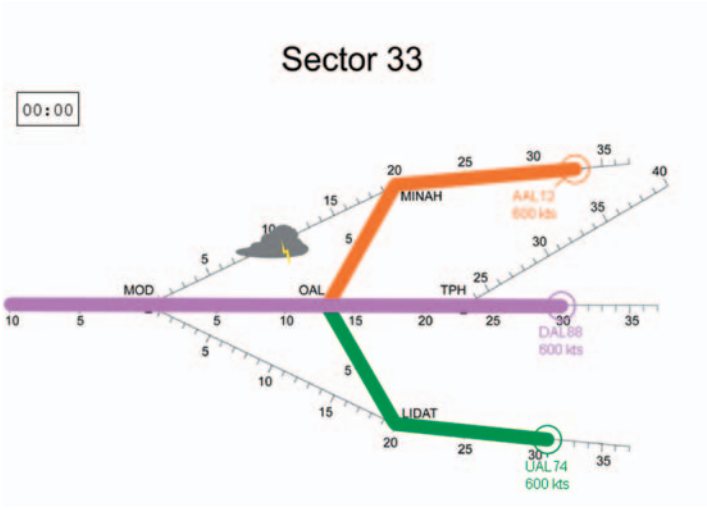
- **DAL88 -** Slow down to 540 knots for 2 minutes to fall back 2 Nmiles. Then speed up to 600 knots.
- **AAL12 -** Slow down to 540 knots for 1 minute to fall back 1 Nmile before OAL. Then speed up to 600 knots.

- **Target Time** - 3:36 mins.

Problem 3-6

Solution

Starting Conditions:



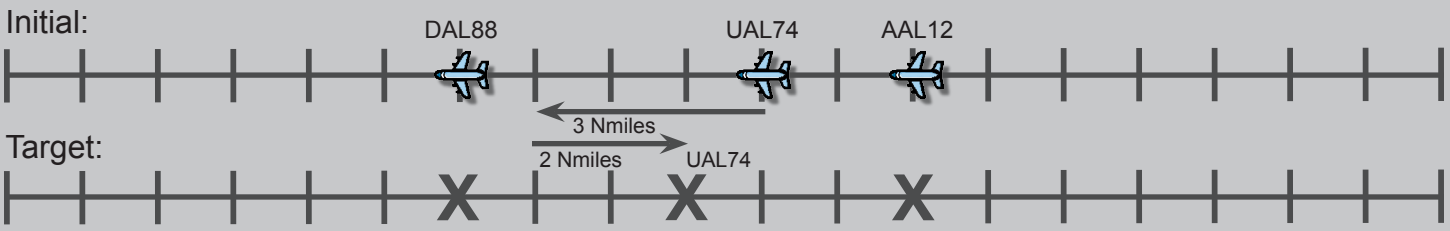
Plane	From	Through	To	Distance	Speed
AAL12	MINAH	OAL	MOD	36	600
DAL88	TPH	OAL	MOD	30	600
UAL74	LIDAT	OAL	MOD	34	600

- Route from **MINAH** to **MOD is closed**.
- Ideal spacing at **MOD** - 3 Nmiles

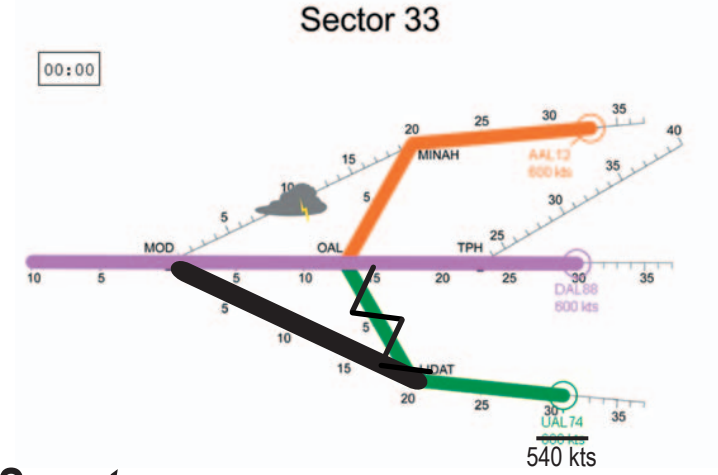
Analysis:

- **AAL12** will arrive at OAL **2 Nmiles** behind **UAL74**.
- **Weather** prevents **AAL12** from rerouting.
- **UAL74** can take the shortcut to shorten its travel distance by 3 Nmiles and then can slow down to fall back 2 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	DAL88	30	4
2nd	UAL74	34	2
3rd	AAL12	36	



Solution:



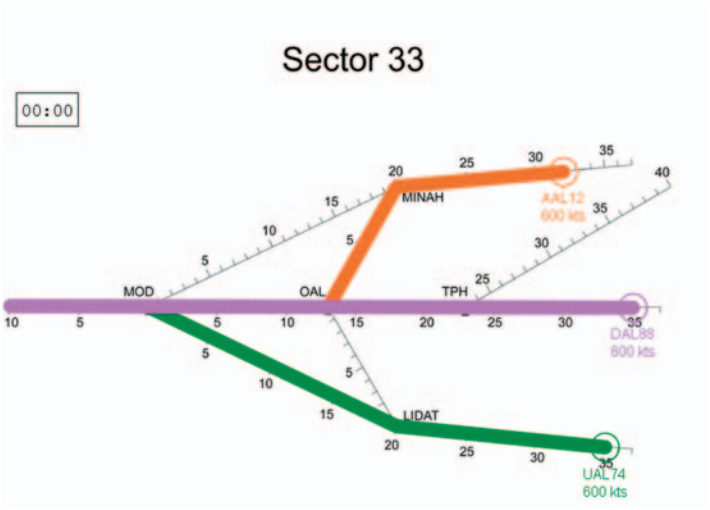
- **UAL74 -** Send direct to MOD to move forward 3 Nmiles and then slow down to 540 knots for 2 minutes to fall back 2 Nmiles. Then speed up to 600 kts.

- **Target Time** - 3:36 mins.

Problem 3-7

Solution

Starting Conditions:



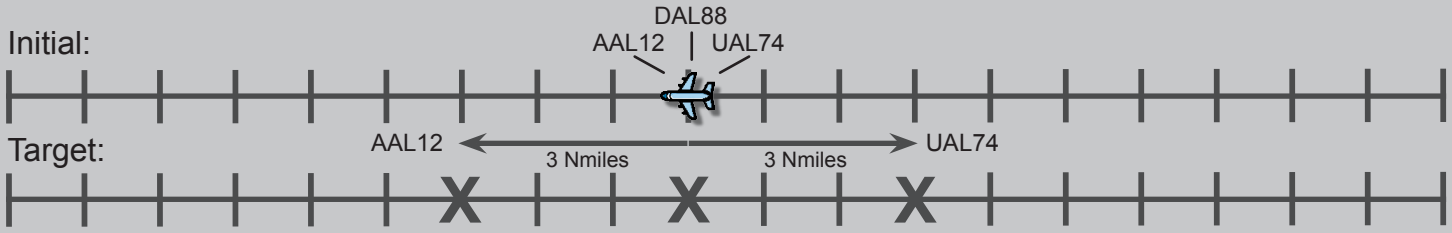
Plane	From	Through	To	Distance	Speed
AAL12	MINAH	OAL	MOD	35	600
DAL88	TPH	OAL	MOD	35	600
UAL74	LIDAT		MOD	35	600

- Ideal spacing at **MOD** - 3 Nmiles

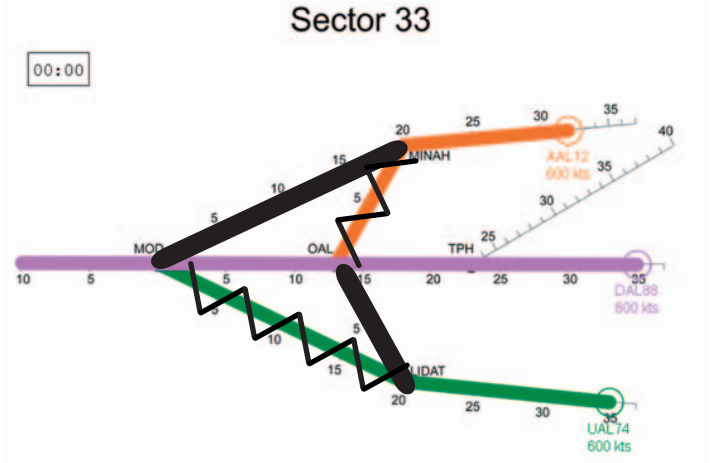
Analysis:

- **Conflict: AAL12, UAL74, AND DAL 88** will arrive at MOD at the same time.
- **AAL12** can take the shortcut to shorten its travel distance by 3 Nmiles.**UAL74** can take the long route through OAL to increase its travel distance by 3 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	UAL74	35	0
2nd	DAL88	35	0
3rd	AAL12	35	



Solution:



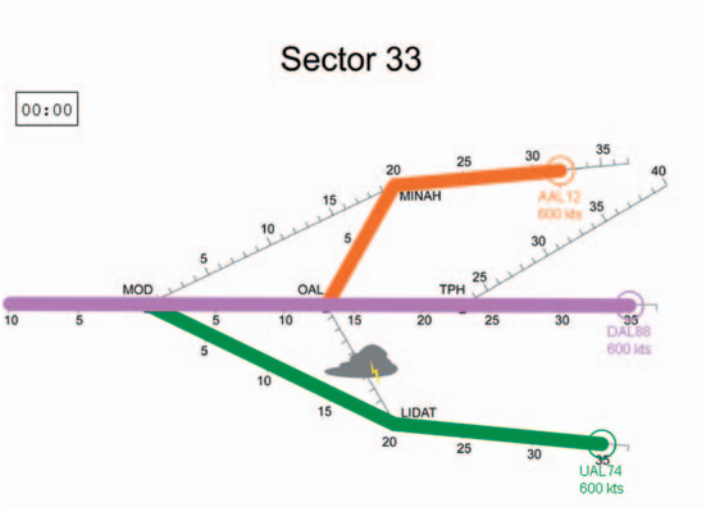
- **AAL12 -** Reroute direct to MOD to move forward 3 Nmiles.
- **UAL74 -** Reroute through OAL to fall back 3 Nmiles.

- **Target Time** - 3:48 mins.

Problem 3-8

Solution

Starting Conditions:



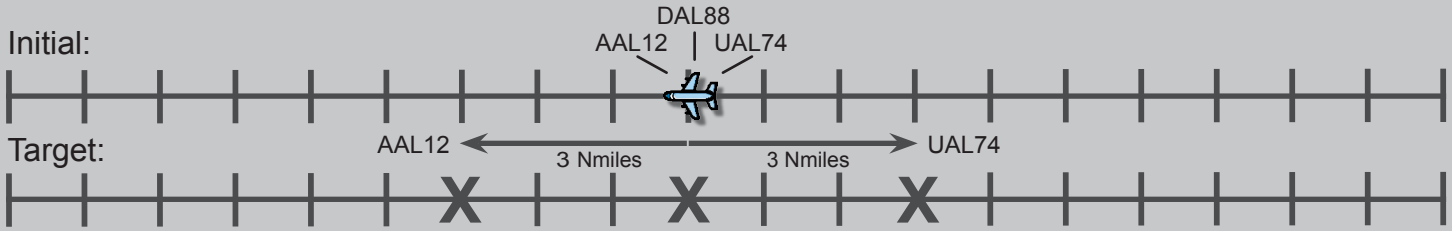
Plane	From	Through	To	Distance	Speed
AAL12	MINAH	OAL	MOD	35	600
DAL88	TPH	OAL	MOD	35	600
UAL74	LIDAT		MOD	35	600

- Route from **LIDAT** to **OAL is closed.**
- Ideal spacing at **MOD** - 3 Nmiles

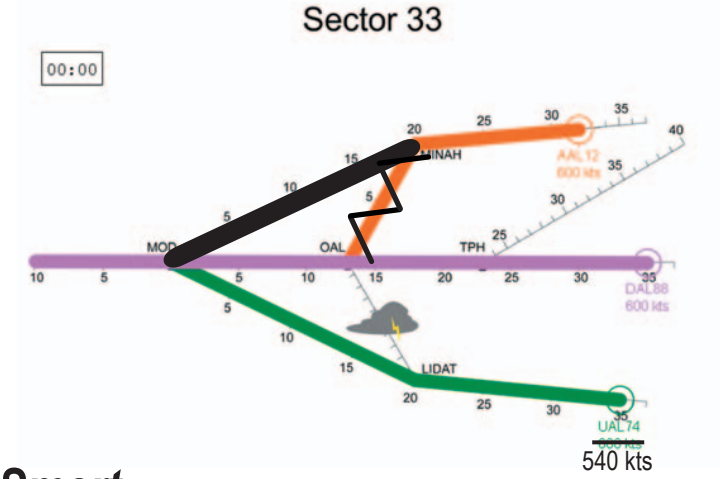
Analysis:

- **Conflict: AAL12, UAL74, AND DAL 88** will arrive at MOD at the same time.
- Weather prevents **UAL74** from rerouting.
- **AAL12** can take the shortcut to shorten its travel distance by 3 Nmiles. **UAL74** can slow down to fall back 3 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	AAL12	35	0
1st	DAL88	35	0
1st	UAL74	35	



Solution:



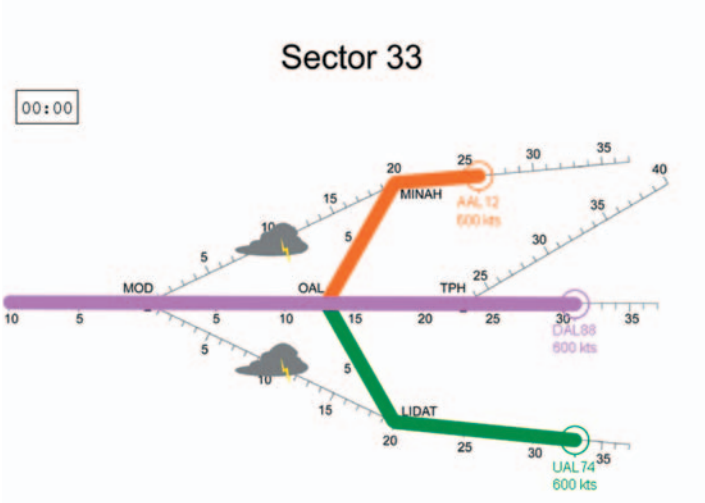
- **AAL12 -** Reroute direct to MOD to move forward 3 Nmiles.
- **UAL74 -** Slow down to 540 knots for 3 minutes to lose 3 Nmiles. Then speed up to 600 knots.

- **Target Time** - 3:48 mins.

Problem 3-9

Solution

Starting Conditions:



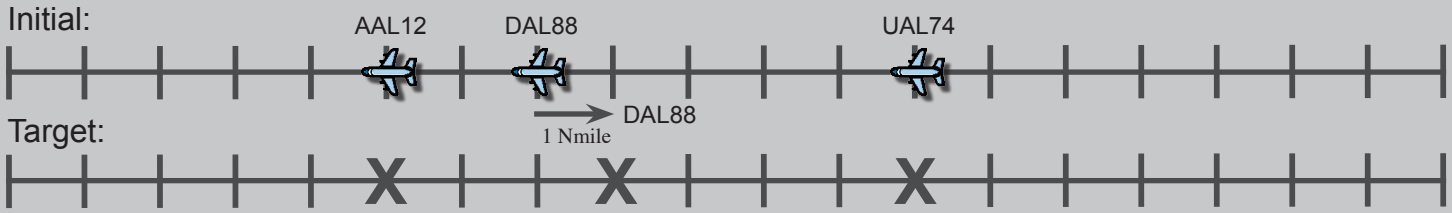
Plane	From	Through	To	Distance	Speed
AAL12	MINAH	OAL	MOD	29	600
DAL88	TPH	OAL	MOD	31	600
UAL74	LIDAT	OAL	MOD	36	600

- Route from **MINAH** to **MOD is closed**.
- Route from **LIDAT** to **MOD is closed**.
- Ideal spacing at **MOD** - 3 Nmiles

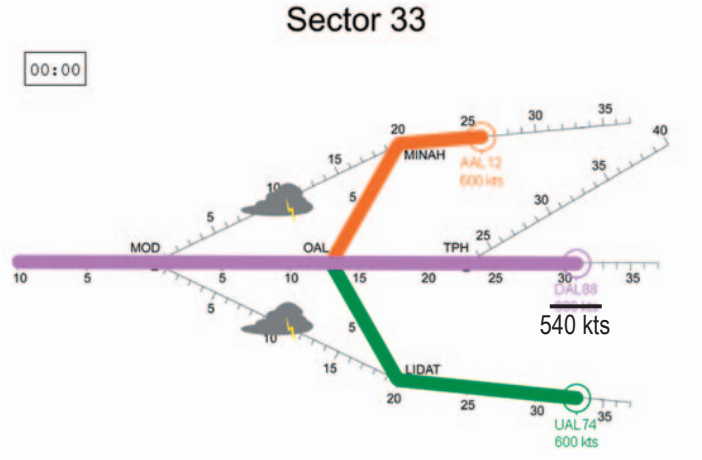
Analysis:

- **DAL88** will arrive at OAL **2 Nmiles** behind **AAL12. UAL74** will be 5 miles behind **DAL88**.
- **Weather** prevents **UAL74** **AND** **AAL12** from rerouting.
- **DAL88** can slow down to fall back 1 Nmile.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	AAL12	29	2
2nd	DAL88	31	5
3rd	UAL74	36	



Solution:



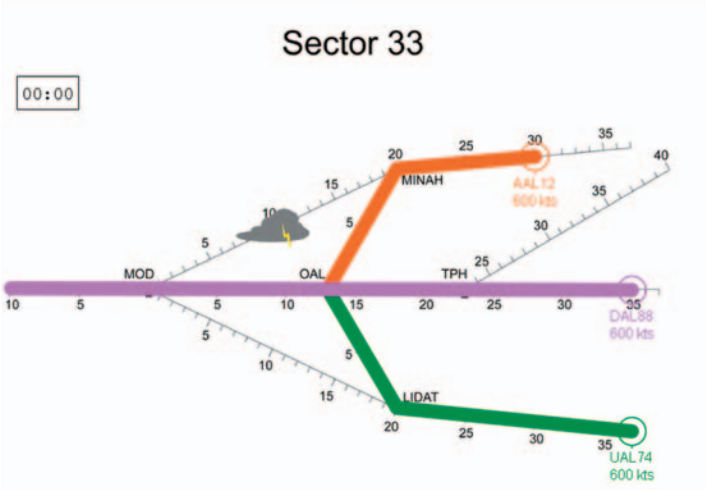
- **DAL88 -** Slow down to 540 knots for 1 minute to fall back 1 Nmile. Then speed up to 600 knots.
- **UAL74** - Spacing is 4 Nmiles. This is greater than 3 Nmiles Ideal Spacing.

- **Target Time** - 3:36 mins.

Problem 3-10

Solution

Starting Conditions:



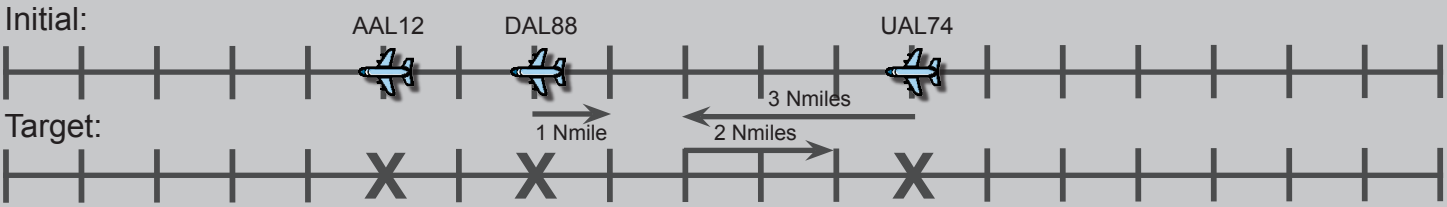
Plane	From	Through	To	Distance	Speed
AAL12	MINAH	OAL	MOD	33	600
DAL88	TPH	OAL	MOD	35	600
UAL74	LIDAT	OAL	MOD	40	600

- Route from **MINAH** to **MOD** **is closed**.
- Ideal spacing at **MOD** - 3 Nmiles

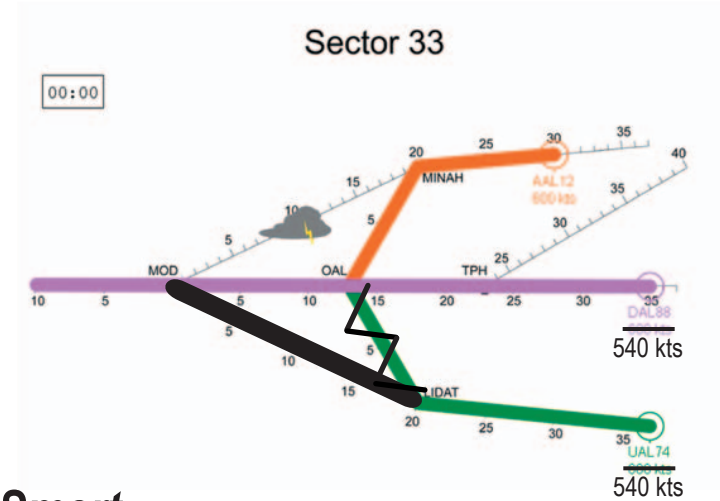
Analysis:

- **DAL88** will arrive at OAL 2 Nmiles behind **AAL12**. **UAL74** will be 5 Nmiles behind.
- **Weather** prevents **AAL12** from rerouting.
- **DAL88** can slow down to fall back 1 Nmile. **UAL74** can take the shortcut to shorten its travel distance by 3 Nmiles and slow down to fall back 2 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	AAL12	33	2
2nd	DAL88	35	5
3rd	UAL74	40	



Solution:



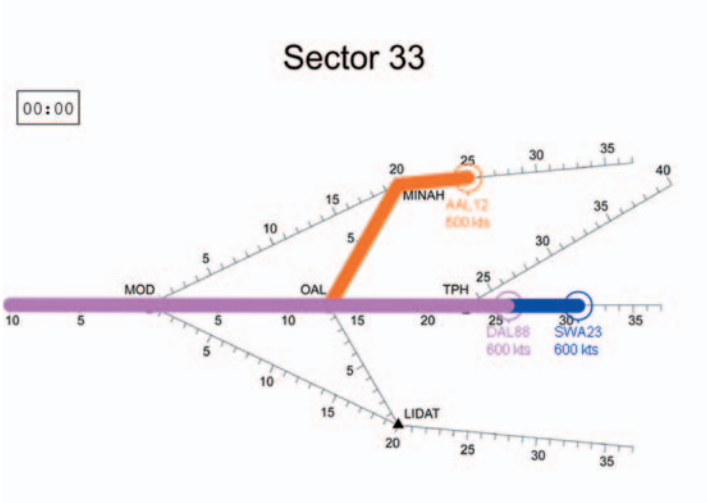
- **DAL88 -** Slow down to 540 knots for 1 minute to fall back 1 Nmile. Then speed up to 600 knots.
- **UAL74 -** Reroute direct to MOD to moveup 3 Nmiles. Slow down to 540 knots for 2 minutes to fall back 2 Nmiles. Then speed up to 600 knots.

- **Target Time** - 3:54 mins.

Problem 3-11

Solution

Starting Conditions:



Plane	From	Through	To	Distance	Speed
AAL12	MINAH	OAL	MOD	28	600
DAL88	TPH	OAL	MOD	26	600
SWA23	TPH	OAL	MOD	31	600

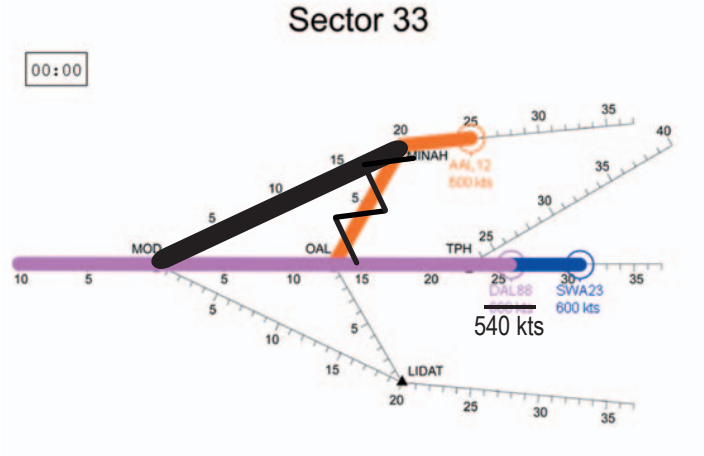
- Ideal spacing at **MOD** - 3 Nmiles

Analysis:

- **AAL12** will arrive at MOD **2 Nmiles** behind **DAL88.**
- **AAL12** can take the shortcut to move into first place. **DAL88** would need to slow down to drop back by 2 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	DAL88	26	2
2nd	AAL12	28	3
3rd	SWA23	31	

Solution:



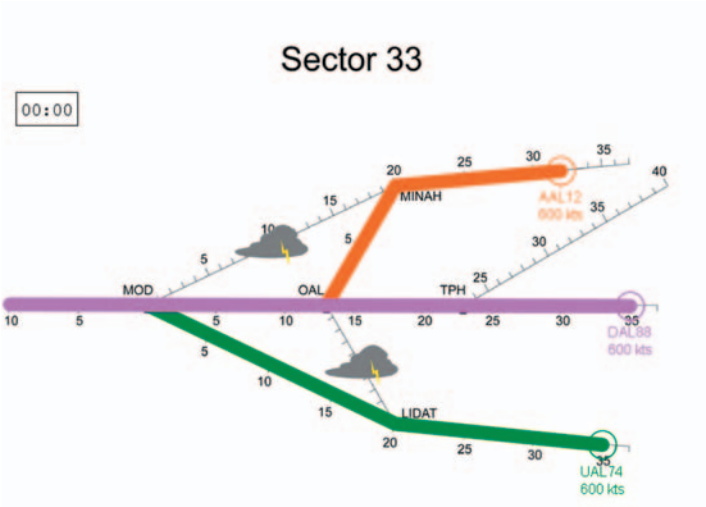
- **AAL12 -** Reroute AAL12 direct to MOD to move forward by 3 Nmiles.
- **DAL88 -** Slow down to 540 knots for 2 minutes to fall back 2 Nmiles. Then speed up to 600 knots.

- **Target Time** - 3:06 mins.

Problem 3-12

Solution

Starting Conditions:



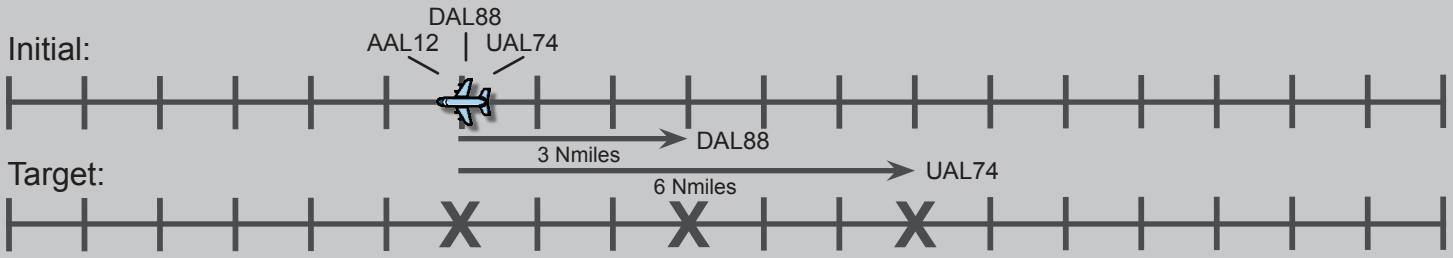
Plane	From	Through	To	Distance	Speed
AAL12	MINAH	OAL	MOD	35	600
DAL88	TPH	OAL	MOD	35	600
UAL74	LIDAT		MOD	35	600

- Route from **LIDAT** to **OAL is closed**.
- Route from **MINAH** to **MOD is closed**.
- Ideal spacing at **MOD** - 3 Nmiles

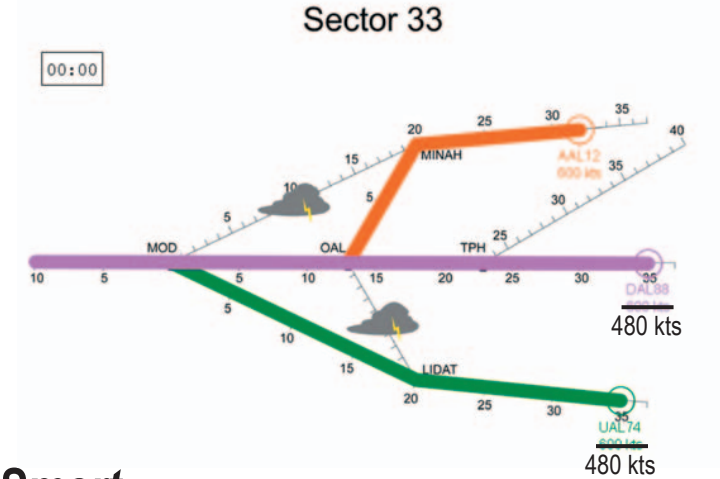
Analysis:

- **Conflict: AAL12, UAL74, AND DAL88** will arrive at MOD at the same time.
- **Weather** prevents **UAL74 AND AAL12** from rerouting.
- One plane must slow down to lose 3 Nmiles and one plane must slow down to lose 6 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	AAL12	35	→ 0
1st	DAL88	35	→ 0
1st	UAL74	35	



Solution:

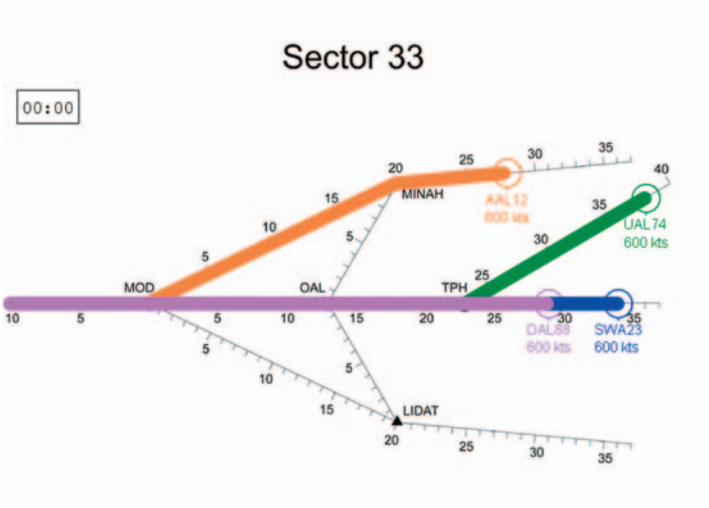


- **UAL74 -** Slow down to 480 knots for 3 minutes to fall back 6 Nmiles (at 5 Nmiles from MOD). Then speed up to 600 knots.
- **DAL88 -** Slow down to 480 knots for 1.5 minutes to fall back 3 Nmiles (at 2 Nmiles from OAL) before a possible conflict at OAL. Then speed up to 600 knots.

Problem 4-1

Solution

Starting Conditions:



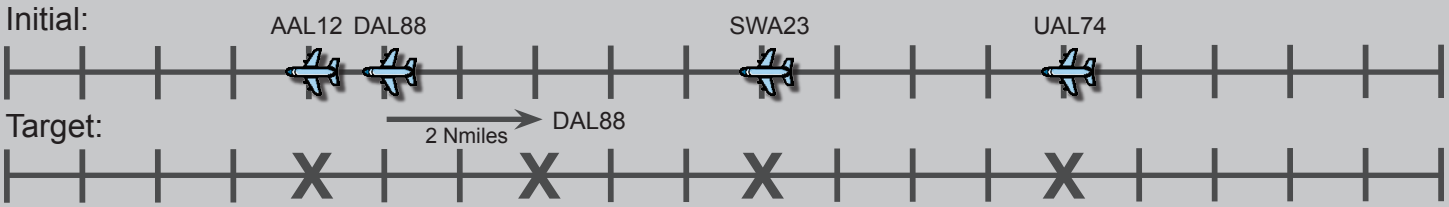
Plane	From	Through	To	Distance	Speed
AAL12	MINAH		MOD	28	600
UAL74	TPH	OAL	MOD	38	600
DAL88	TPH	OAL	MOD	29	600
SWA23	TPH	OAL	MOD	34	600

- Ideal spacing at **MOD** - 3 Nmiles

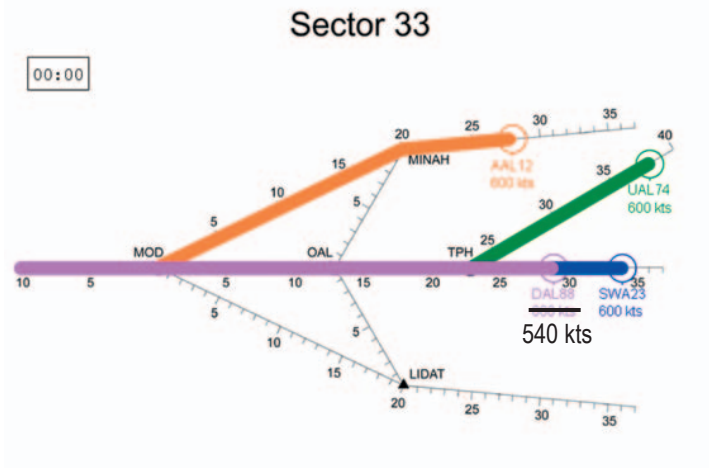
Analysis:

- **Conflict: DAL88** will arrive at MOD **1 Nmile** behind **AAL12**.
- **DAL88** can slow down to fall back 2 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	AAL12	28	1
2nd	DAL88	29	5
3rd	SWA23	34	4
4th	UAL74	38	



Solution:



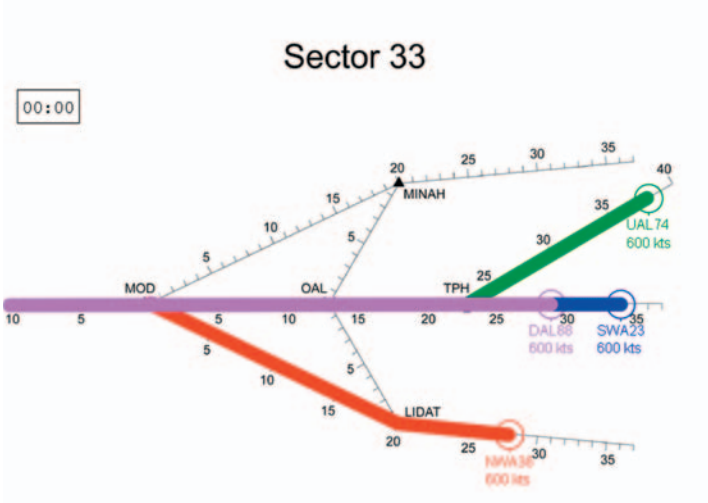
- **DAL88 -** Slow down to 540 knots for 2 minutes to fall back 2 Nmiles. Then speed up to 600 knots.
  Note: UAL74 can not achieve 3 Nmiles Ideal Spacing.

- **Target Time** - 3:48 mins.

Problem 4-2

Solution

Starting Conditions:



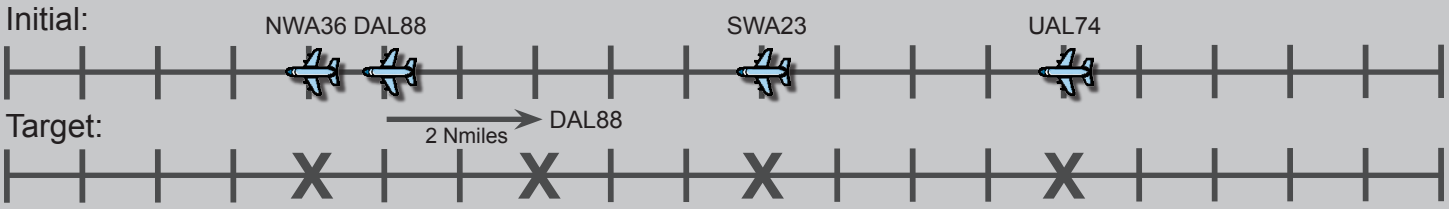
Plane	From	Through	To	Distance	Speed
UAL74	TPH	OAL	MOD	38	600
DAL88	TPH	OAL	MOD	29	600
SWA23	TPH	OAL	MOD	34	600
NWA36	LIDAT		MOD	28	600

- Ideal spacing at **MOD** - 3 Nmiles

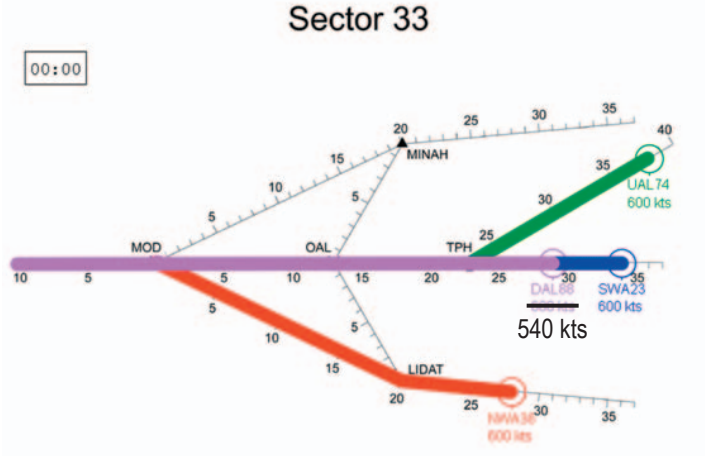
Analysis:

- **Conflict: DAL88** will arrive at MOD **1 Nmile** behind **NWA36**.
- **DAL88** can slow down to fall back 2 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	NWA36	28	1
2nd	DAL88	29	5
3rd	SWA23	34	4
4th	UAL74	38	



Solution:



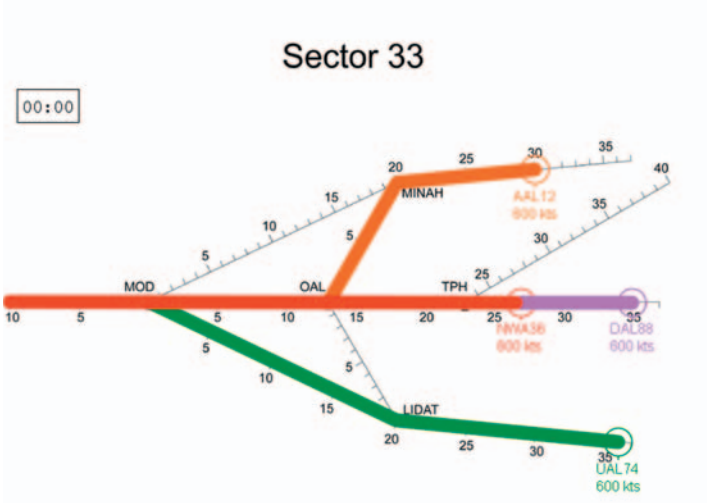
- **DAL88 -** Slow down to 540 knots 2 minutes to fall back 2 Nmiles. Then speed up to 600 knots.
  Note: UAL74 can not achieve 3 Nmile Ideal Spacing.

- **Target Time** - 3:48 mins.

Problem 4-3

Solution

Starting Conditions:



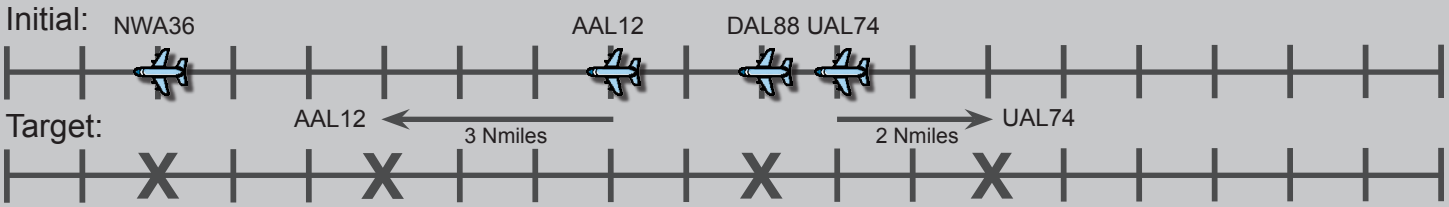
Plane	From	Through	To	Distance	Speed
AAL12	MINAH	OAL	MOD	33	600
NWA36	TPH	OAL	MOD	27	600
DAL88	TPH	OAL	MOD	35	600
UAL74	LIDAT		MOD	36	600

- Ideal spacing at **MOD** - 3 Nmiles

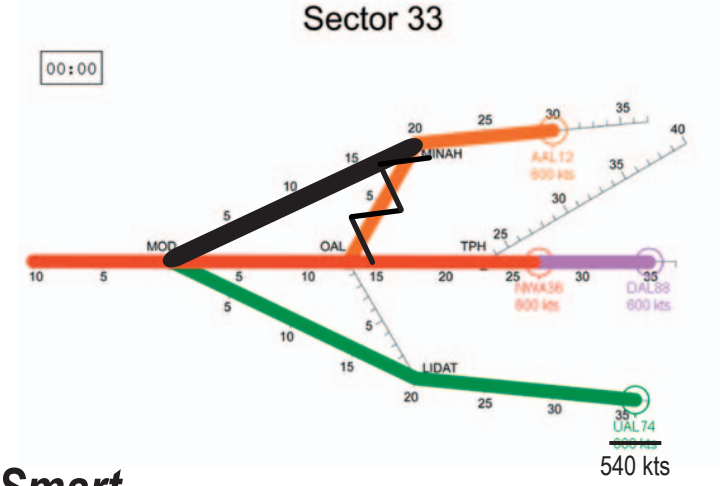
Analysis:

- **Conflict:** **UAL74** will arrive at MOD **1 Nmile** behind **DAL88**.
- **AAL12** will arrive at MOD **2 Nmiles** ahead of **DAL88**.
- **AAL12** can take the shortcut to shorten its travel distance by 3 Nmiles. **UAL74** can slow down to fall back 2 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	NWA36	27	6
2nd	AAL12	33	2
3rd	DAL88	35	1
4th	UAL74	36	



Solution:



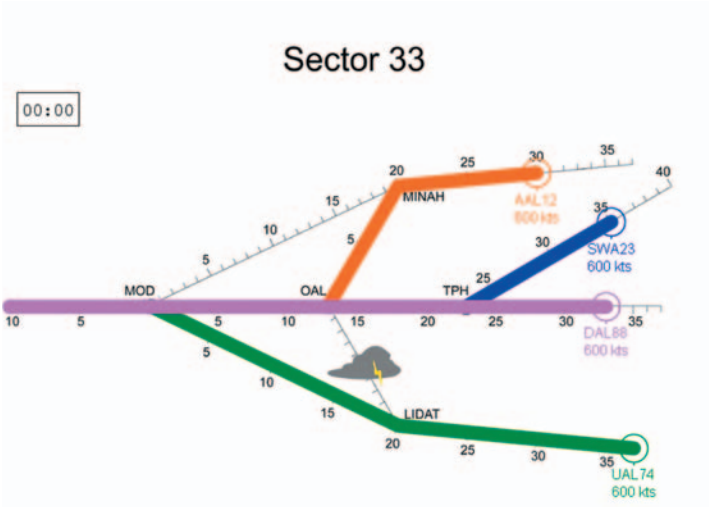
- **AAL12 -** Reroute direct to MOD to move forward 2 Nmiles.
- **UAL74 -** Slow down to 540 knots 2 minutes to fall back 2 Nmiles. Then speed up to 600 knots.
  Note: DAL88 can not achieve 3 Nmile Ideal Spacing.

- **Target Time** - 3:48 mins.

Problem 4-4

Solution

Starting Conditions:



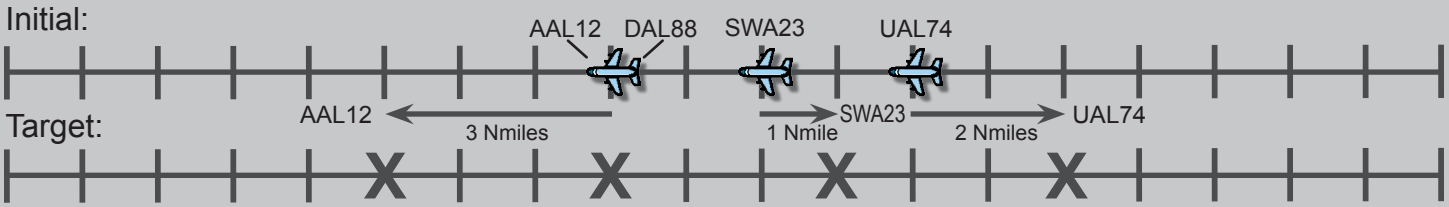
Plane	From	Through	To	Distance	Speed
AAL12	MINAH	OAL	MOD	33	600
SWA23	TPH	OAL	MOD	35	600
DAL88	TPH	OAL	MOD	33	600
UAL74	LIDAT		MOD	37	600

- Route from **LIDAT** to **OAL is closed**.
- Ideal spacing at **MOD** - 3 Nmiles

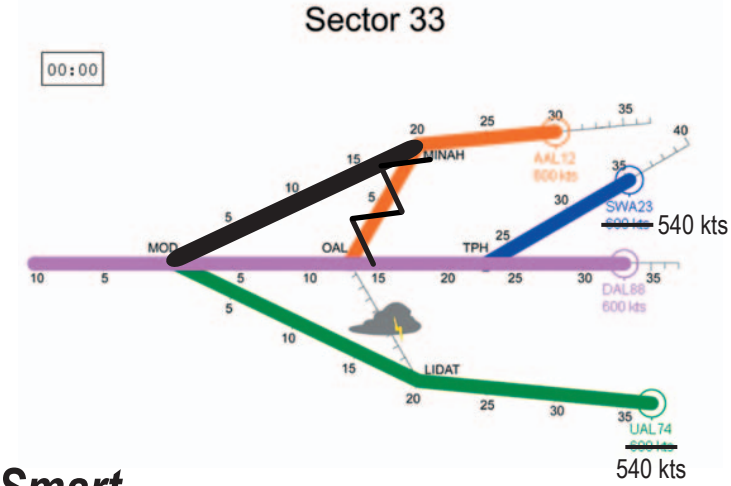
Analysis:

- **Conflict:** **DAL88** **AND** **AAL12** will arrive at the same time **at OAL**.
- **SWA23** will arrive **2 Nmiles** behind **DAL88** at MOD. **UAL74** will arrive **2 Nmiles** behind **SWA23** at MOD.
- **Weather** prevents **UAL74** from rerouting.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	AAL12	33	0
1st	DAL88	33	2
3rd	SWA23	35	2
4th	UAL74	37	



Solution:



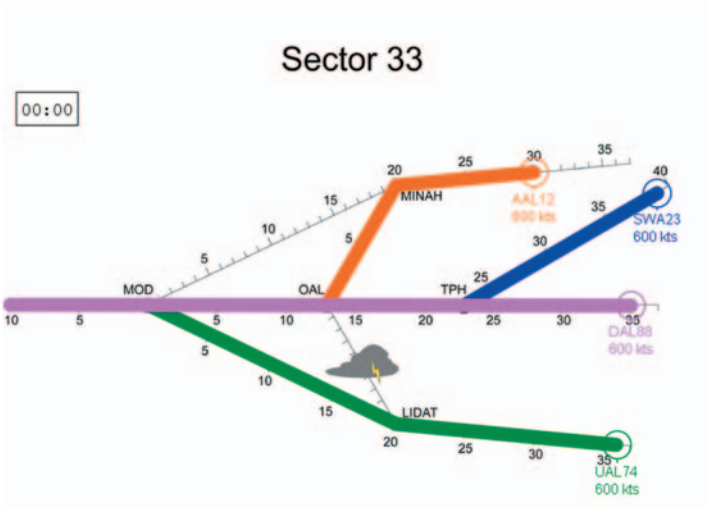
- **AAL12 -** Reroute direct MOD to move forward 3 Nmiles.
- **SWA23 -** Slow down to 540 knots for 1 minute to fall back 1 Nmile. Then speed up to 600 knots.
- **UAL74 -** Slow down to 540 knots 2 minutes to fall back 2 Nmiles. Then speed up to 600 knots.

- **Final Time** – 3:54 mins.

Problem 4-5

Solution

Starting Conditions:



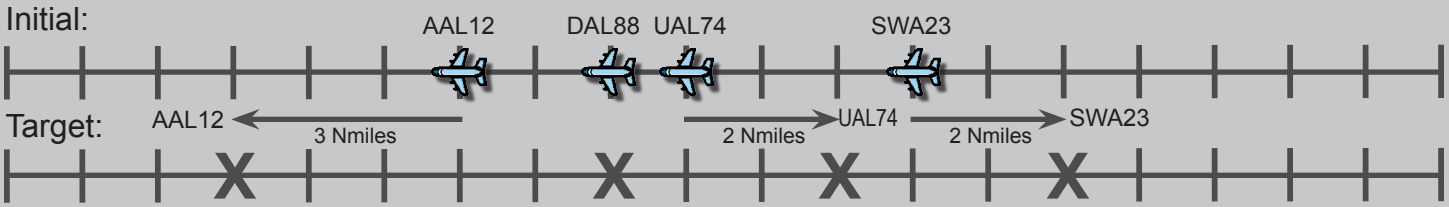
Plane	From	Through	To	Distance	Speed
AAL12	MINAH	OAL	MOD	33	600
SWA23	TPH	OAL	MOD	39	600
DAL88	TPH	OAL	MOD	35	600
UAL74	LIDAT		MOD	36	600

- Route from **LIDAT** to **OAL is closed**.
- Ideal spacing at **MOD** - 3 Nmiles

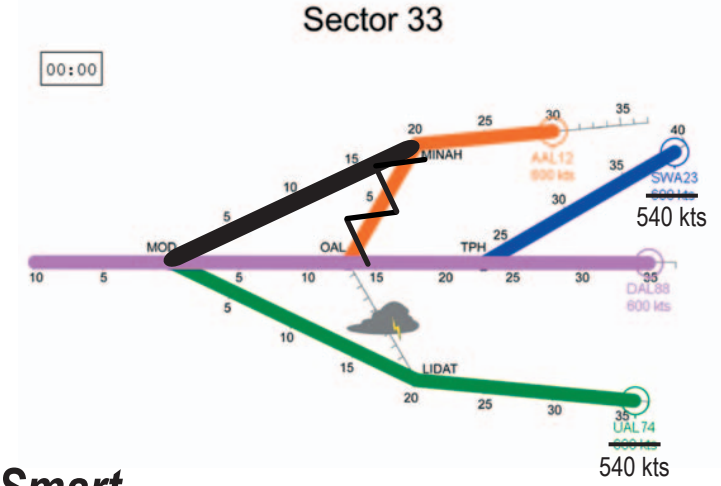
Analysis:

- **Conflict:** **UAL74** will arrive at MOD **1 Nmile** behind **DAL88**.
- **AAL12** will arrive **2 Nmiles** ahead of **DAL88** at MOD.
- **Weather** prevents **UAL74** from rerouting.
- **AAL12** can take the shortcut to shorten its travel distance. **UAL74** can slow down to fall back **2 Nmiles**. **SWA23** can slow down to fall back 2 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	AAL12	33	2
2nd	DAL88	35	1
3rd	UAL74	36	3
4th	SWA23	39	



Solution:



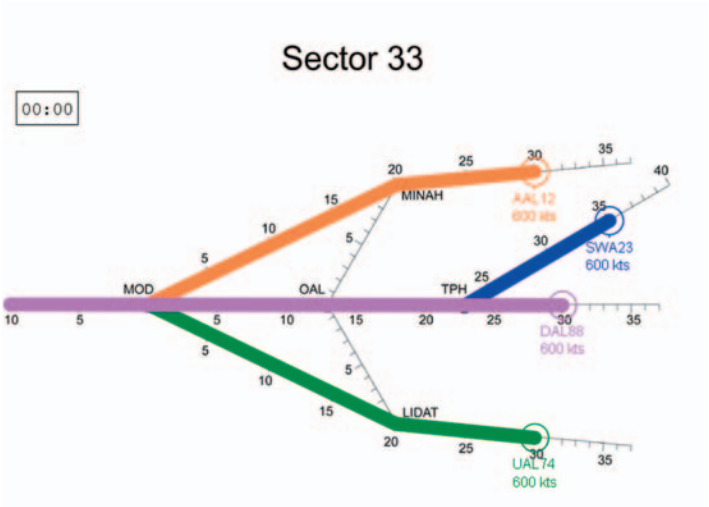
- **AAL12 -** Reroute direct to MOD to move forward 3 Nmiles.
- **UAL74 -** Slow down to 540 knots for 2 minutes to fall back 2 Nmiles. Then speed up to 600 knots.
- **SWA23 -** Slow down to 540 knots for 2 minutes to fall back 2 Nmiles. Then speed up to 600 knots.

- **Target Time** - 4:06 mins.

Problem 4-6

Solution

Starting Conditions:



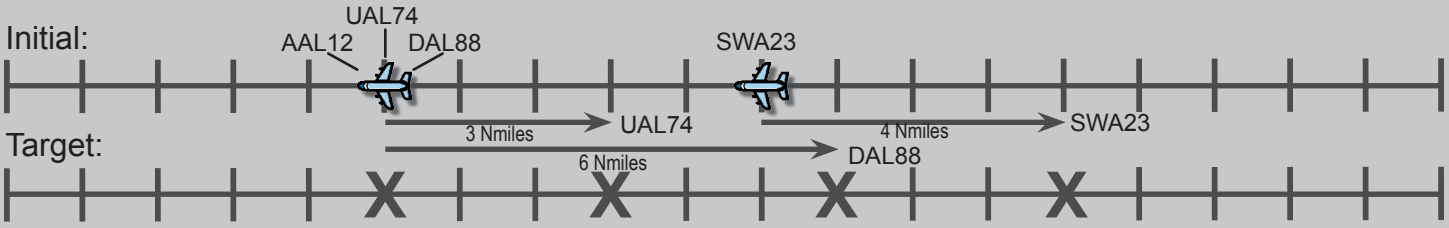
Plane	From	Through	To	Distance	Speed
AAL12	MINAH		MOD	30	600
SWA23	TPH	OAL	MOD	35	600
DAL88	TPH	OAL	MOD	30	600
UAL74	LIDAT		MOD	30	600

- Ideal spacing at **MOD** - 3 Nmiles

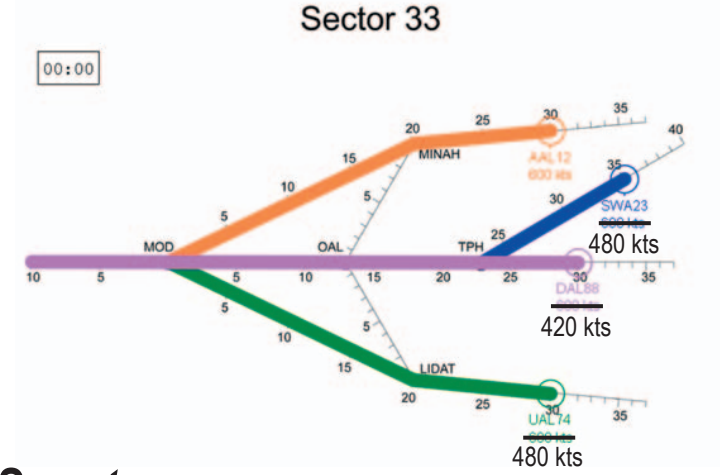
Analysis:

- **Conflict: UAL74, DAL88, AND AAL12** will arrive at MOD at the same time.
- All planes except **one of these** need to fall back a lot. **AAL12** and **UAL74** can either be rerouted or slowed down.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	AAL12	30	0
1st	UAL74	30	0
1st	DAL88	30	5
4th	SWA23	35	



Solution:



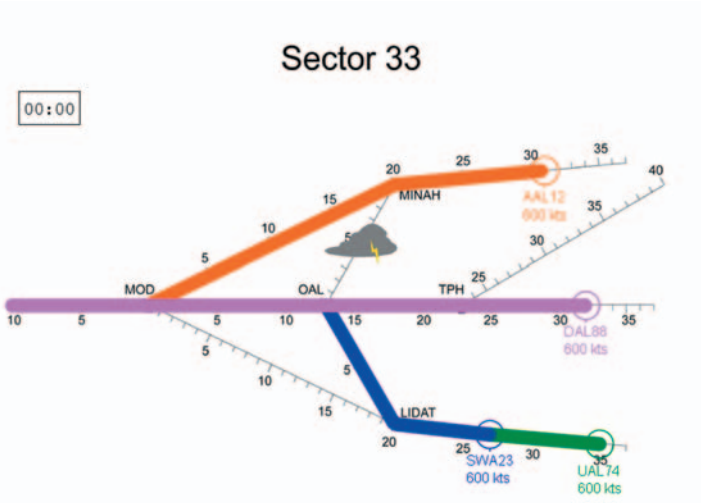
- **UAL74 -** Slow down to 480 knots for 1.5 minutes to fall back 3 Nmiles. Then speed up to 600 knots.
- **SWA23 -** Slow down to 480 knots for 2 minutes to fall back 4 Nmiles. Then speed up to 600 knots.
- **DAL88 -** Slow down to 420 knots for 2 minutes to fall back 6 Nmiles. Then speed up to 600 knots.

- **Target Time** - 3:54 mins.

Problem 4-7

Solution

Starting Conditions:



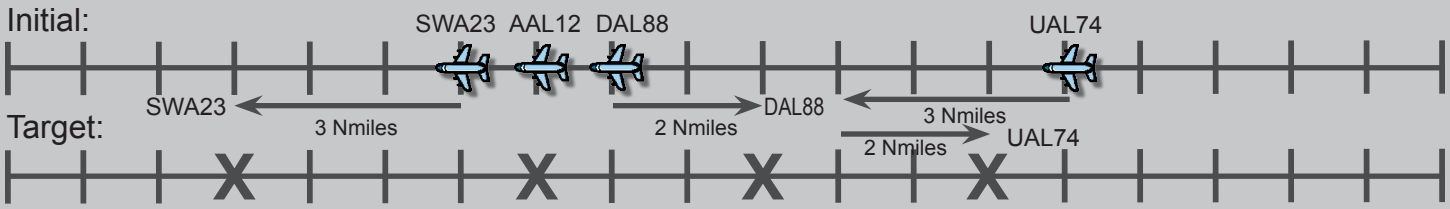
Plane	From	Through	To	Distance	Speed
AAL12	MINAH		MOD	31	600
DAL88	TPH	OAL	MOD	32	600
SWA23	LIDAT	OAL	MOD	30	600
UAL74	LIDAT	OAL	MOD	38	600

- Route from **MINAH** to **OAL is closed**
- Ideal spacing at **MOD** - 3 Nmiles

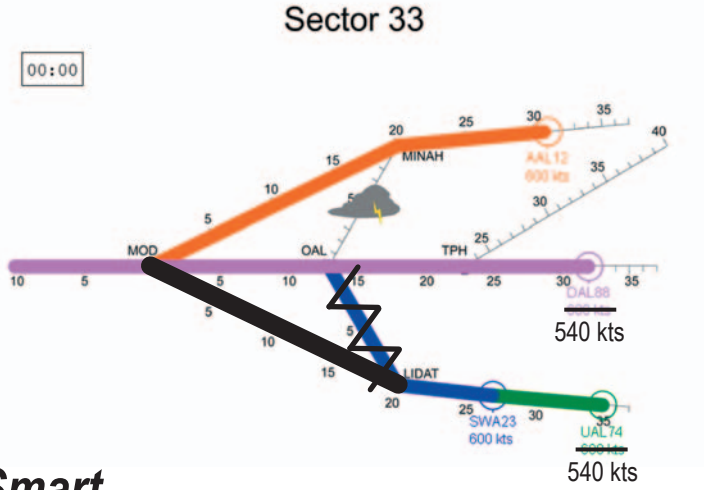
Analysis:

- **Conflict: SWA23, AAL12, and DAL88** have only **1 Nmile** separation at MOD.
- **Weather** prevents AAL12 from rerouting.
- **SWA23** can take the shortcut to move forward 3 Nmiles. **DAL88** can slow down to fall back 2 Nmiles. **UAL74** can take the shortcut to move forward 3 Nmiles and slow down to fall back 2 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	SWA23	30	
2nd	AAL12	31	1
3rd	DAL88	32	1
4th	UAL74	38	6



Solution:



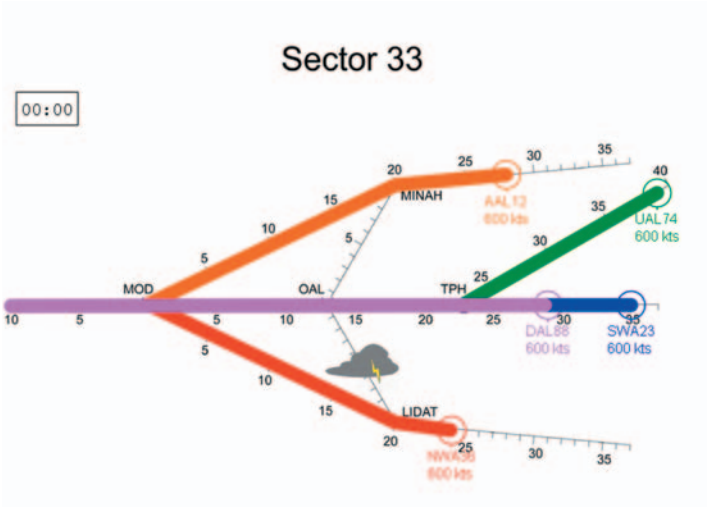
- **SWA23 -** Reroute direct MOD to move forward 3 Nmiles.
- **DAL88 -** Slow down to 540 knots for 2 minutes to fall back 2 Nmiles. Then speed up to 600 knots.
- **UAL74 -** Reroute direct MOD to move forward 3 Nmiles, and then slow down to 540 knots for 2 minutes to fall back 2 Nmiles. Then speed up to 600 knots.
  Note: AAL12 cannot achieve 3 Nmile Ideal Spacing.

- **Target Time** - 3:42 mins.

Problem 5-1

Solution

Starting Conditions:



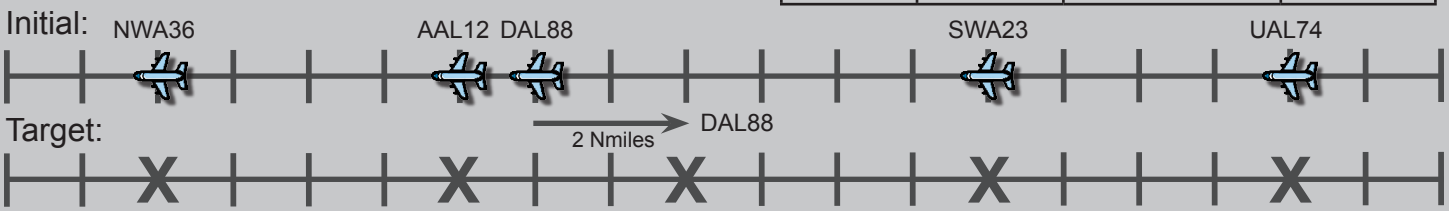
Plane	From	Through	To	Distance	Speed
AAL12	MINAH		MOD	28	600
UAL74	TPH	OAL	MOD	39	600
DAL88	TPH	OAL	MOD	29	600
SWA23	TPH	OAL	MOD	35	600
NWA36	LIDAT		MOD	24	600

- Route from **LIDAT** to **OAL is closed**.
- Ideal spacing at **MOD** - 3 Nmiles

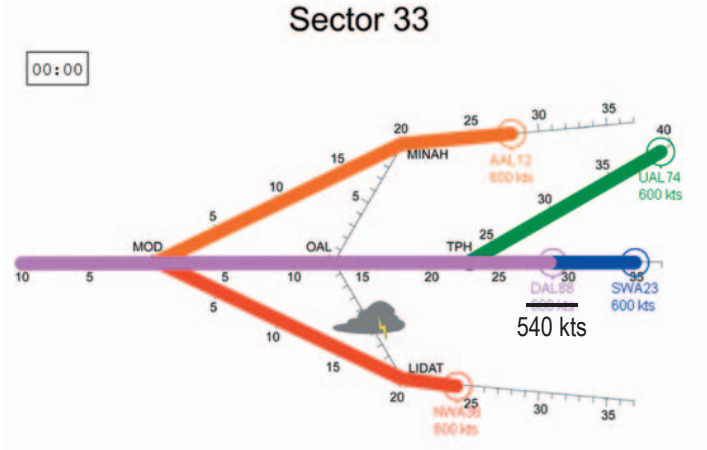
Analysis:

- **Conflict:** **DAL88** will arrive at MOD **1 Nmile** behind **AAL12**.
- **Weather** prevents **NWA36** from rerouting.
- **DAL88** can slow down to fall back 2 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	NWA36	24	4
2nd	AAL12	28	1
3rd	DAL88	29	6
4th	SWA23	35	4
5th	UAL74	39	



Solution:



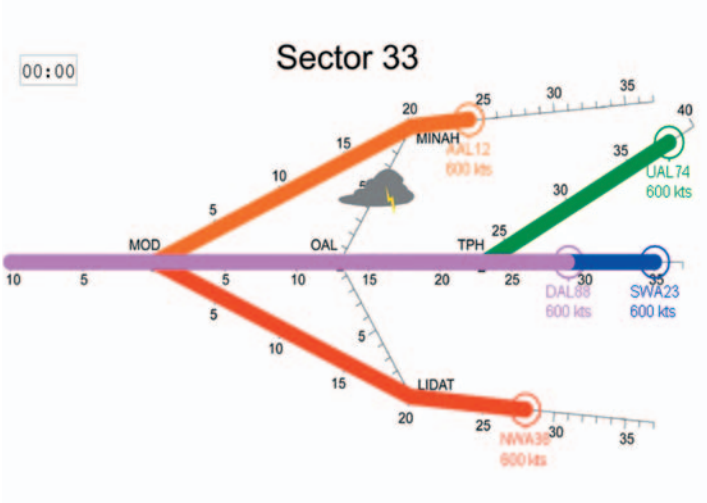
- **DAL88 -** Slow down to 540 knots for 2 minutes to fall back 2 Nmiles. Then speed up to 600 knots.
  Note: Not all planes can achieve 3 Nmile Ideal Spacing.

- **Target Time** - 3:54 mins.

Problem 5-2

Solution

Starting Conditions:



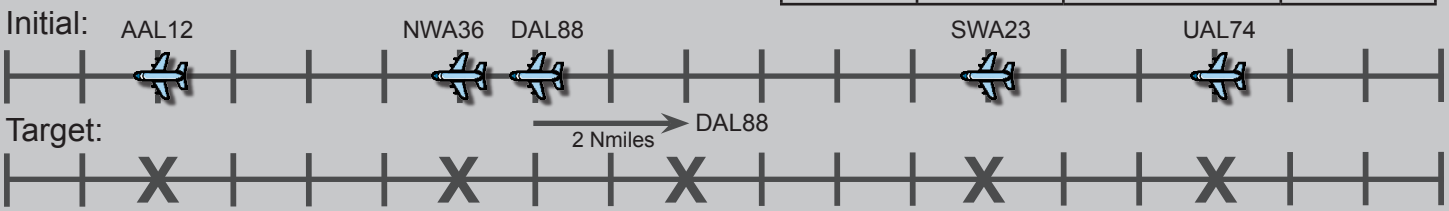
Plane	From	Through	To	Distance	Speed
AAL12	MINAH		MOD	24	600
UAL74	TPH	OAL	MOD	38	600
DAL88	TPH	OAL	MOD	29	600
SWA23	TPH	OAL	MOD	35	600
NWA36	LIDAT		MOD	28	600

- Route from **MINAH** to **OAL is closed**.
- Ideal spacing at **MOD** - 3 Nmiles

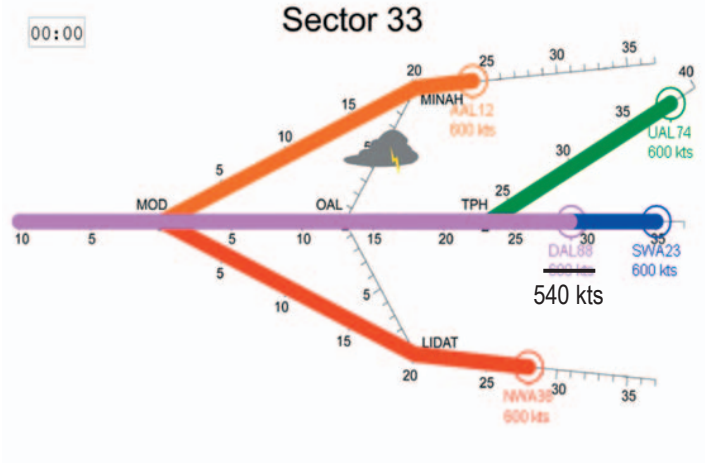
Analysis:

- **Conflict:** **DAL88** will arrive at MOD **1 Nmile** behind **NWA36**.
- **Weather** prevents **AAL12** from rerouting.
- **DAL88** can slow down to fall back 2 Nmiles.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	AAL12	24	→ 4
2nd	NWA36	28	→ 1
3rd	DAL88	29	→ 6
4th	SWA23	35	→ 3
5th	UAL74	38	



Solution:



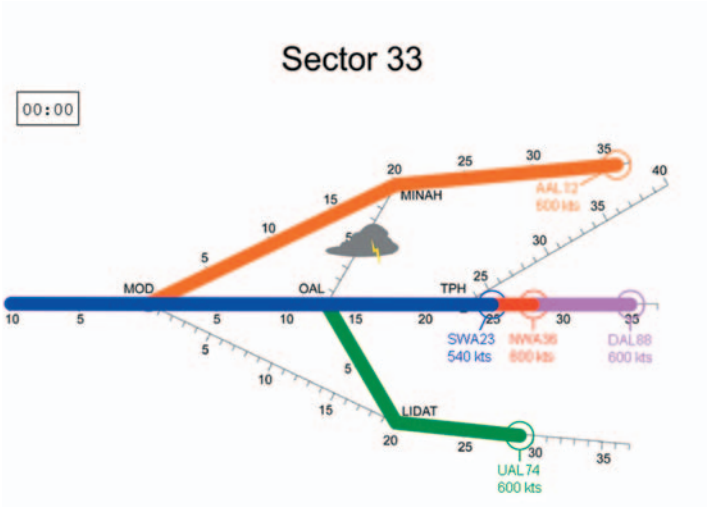
- **DAL88 -** Slow down to 540 knots for 2 minutes to fall back 2 Nmiles. Then speed up to 600 knots.
  Note: Not all planes can achieve 3 Nmile Ideal Spacing.

- **Target Time** - 3:48 mins.

Problem 5-3

Solution

Starting Conditions:



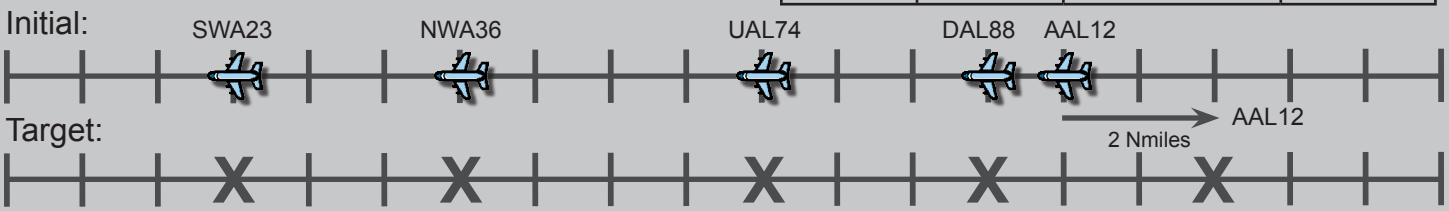
Plane	From	Through	To	Distance	Speed
AAL12	MINAH		MOD	36	600
SWA23	TPH	OAL	MOD	25	**540**
NWA36	TPH	OAL	MOD	28	600
DAL88	TPH	OAL	MOD	35	600
UAL74	LIDAT	OAL	MOD	32	600

- Route from **MINAH** to **OAL is closed**.
- Ideal spacing at **MOD** - 3 Nmiles

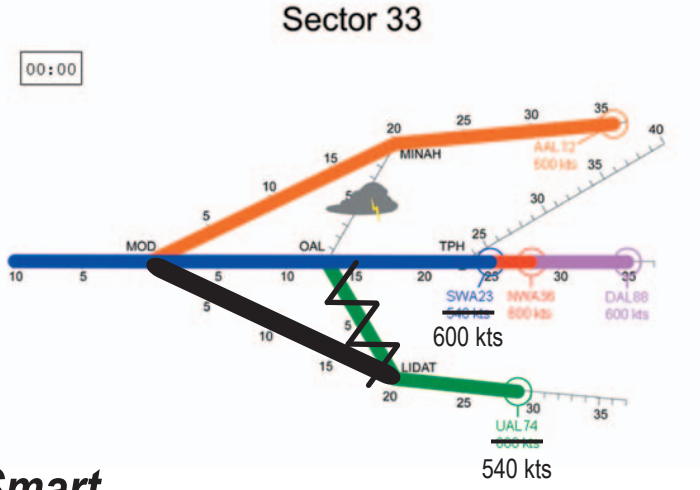
Analysis:

- **Conflict: AAL12** will arrive at MOD **1 Nmile** behind **DAL88**.
- **Weather** prevents **AAL12** from rerouting.
- **SWA23** needs to speed up to 600 knots to keep 3 Nmiles spacing with **NWA36.**
- **AAL12** can slow down to fall back 2 Nmiles

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	SWA23	25	
2nd	NWA36	28	3
3rd	UAL74	32	4
4th	DAL88	35	3
5th	AAL12	36	1



Solution:



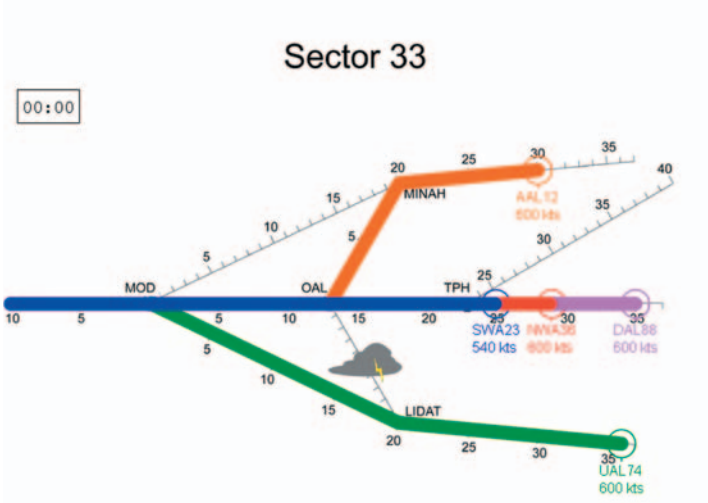
- **SWA23 -** Speed up to 600 knots.
- **AAL12 -** Slow down to 540 knots for 2 minutes to fall back 2 Nmiles. Then speed up to 600 knots.
  Note: UAL74 can not achieve 3 Nmile Ideal Spacing.

- **Target Time** - 3:48 mins.

Problem 5-4

Solution

Starting Conditions:



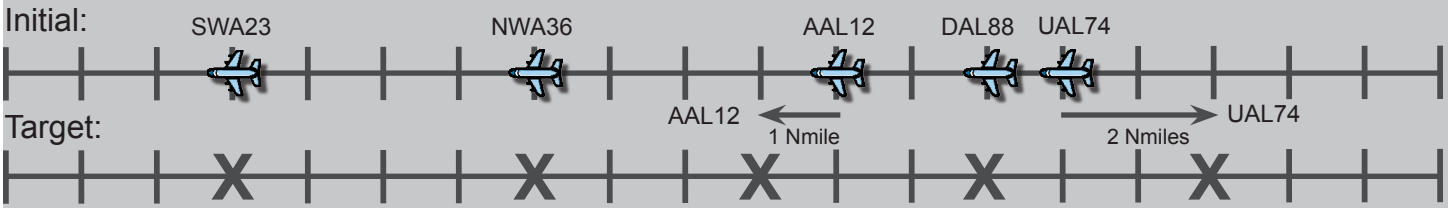
Plane	From	Through	To	Distance	Speed
AAL12	MINAH	OAL	MOD	33	600
SWA23	TPH	OAL	MOD	25	**540**
NWA36	TPH	OAL	MOD	29	600
DAL88	TPH	OAL	MOD	35	600
UAL74	LIDAT		MOD	36	600

- Route from **LIDAT** to **OAL is closed**.
- Ideal spacing at MOD - 3 Nmiles

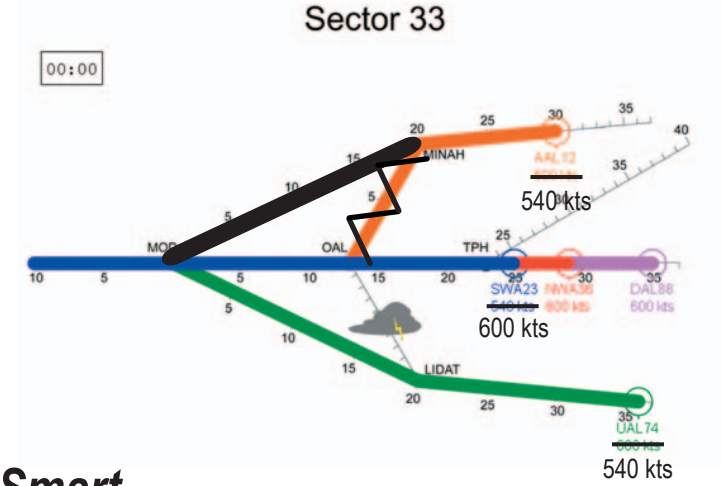
Analysis:

- **Conflict:** **UAL74** will arrive at MOD **1 Nmile** behind **DAL88**.
- **AAL12** will arrive at MOD **2 Nmiles** ahead of **DAL88.**
- **Weather** prevents **UAL74** from rerouting.
- **AAL12** can take the shortcut to move forward 3 Nmiles, and slow down to fall back 2 Nmiles. **UAL74** can slow down to fall back 2 Nmiles.
- **SWA23** needs to speed up to 600 knots.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	SWA23	25	→ 4
2nd	NWA36	29	→ 4
3rd	AAL12	33	→ 2
4th	DAL88	35	→ 1
5th	UAL74	36	



Solution:



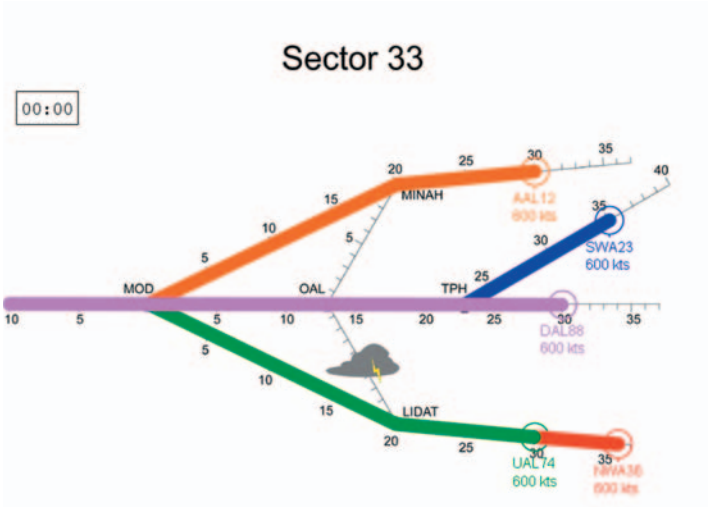
- **SWA23 -** Speed up to 600 knots immediately.
- **AAL12 -** Reroute direct MOD to move forward 3 Nmiles, and slow down to 540 knots for 2 minutes to fall back 2 Nmiles. Then speed up to 600 knots.
- **UAL74 -** Slow down to 540 knots for 2 minutes to fall back 2 Nmiles. Then speed up to 600 knots.

- **Target Time** - 3:48 mins.

Problem 5-5

Solution

Starting Conditions:



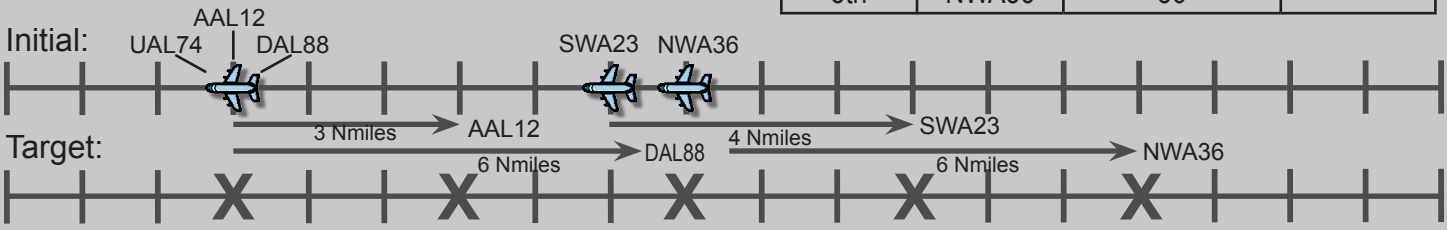
Plane	From	Through	To	Distance	Speed
AAL12	MINAH		MOD	30	600
SWA23	TPH	OAL	MOD	35	600
DAL88	TPH	OAL	MOD	30	600
UAL74	LIDAT		MOD	30	600
NWA36	LIDAT		MOD	36	600

- Route from **LIDAT** to **OAL is closed**.
- Ideal spacing at **MOD** - 3 Nmiles

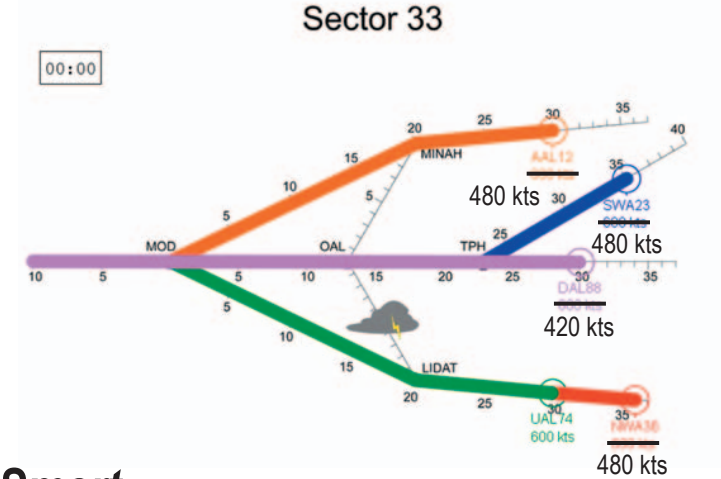
Analysis:

- **Conflict: UAL74, DAL88, AND AAL12** will arrive at MOD at the same time, **and NWA36** will arrive **1 Nmile** behind **SWA23** at MOD.
- **Weather** prevents **UAL74 and NWA36** from rerouting.
- All planes except **UAL74** need to fall back a lot. **AAL12** can be slowed down (rerouting creates early conflicts).

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	UAL74	30	
1st	AAL12	30	0
1st	DAL88	30	0
4th	SWA23	35	5
5th	NWA36	36	1



Solution:



- **NWA36 -** Slow down to 480 knots for 3 minutes to fall back 6 Nmiles. Then speed up to 600 knots.
- **SWA23 -** Slow down to 480 knots for 2 minutes to fall back 4 Nmiles. Then speed up to 600 knots.
- **DAL88 -** Slow down to 420 knots for 2 minutes to fall back 6 Nmiles. Then speed up to 600 knots.
- **AAL12 -** Slow down to 480 knots for 1.5 minutes to fall back 3 Nmiles. Then speed up to 600 knots.

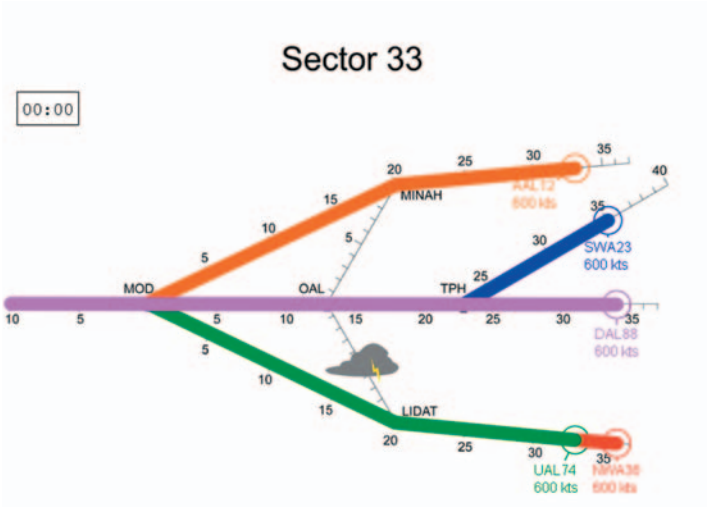
Note: To provide enough time to slow down and speed up so many planes, you need to make greater than typical speed reductions.

- **Target Time** - 4:12 mins.

Problem 5-6

Solution

Starting Conditions:



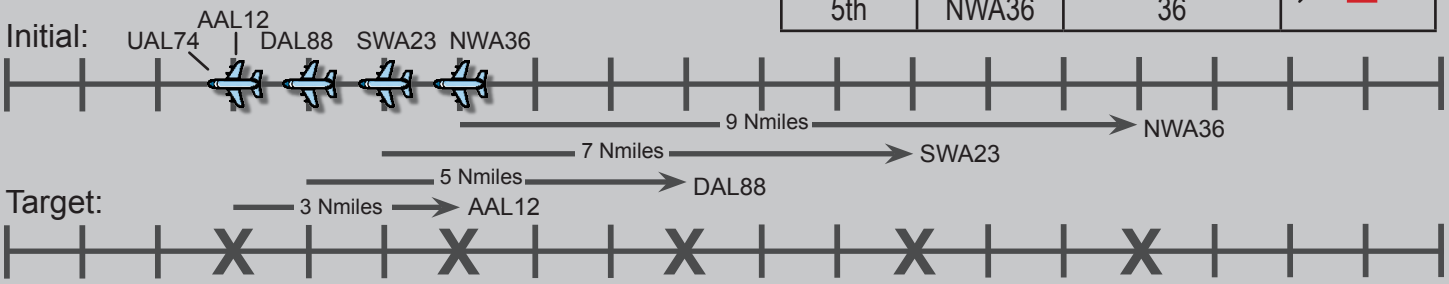
Plane	From	Through	To	Distance	Speed
AAL12	MINAH		MOD	33	600
SWA23	TPH	OAL	MOD	35	600
DAL88	TPH	OAL	MOD	34	600
UAL74	LIDAT		MOD	33	600
NWA36	LIDAT		MOD	36	600

- Route from **LIDAT** to **OAL** is closed
- Ideal spacing at **MOD** - 3 Nmiles

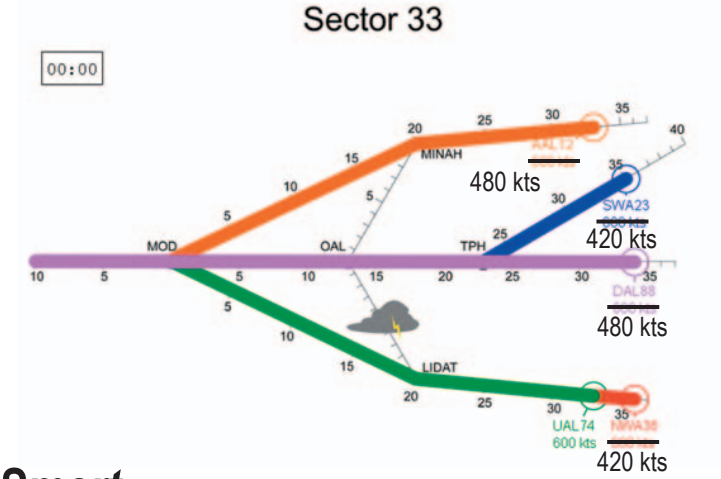
Analysis:

- **Conflict:** **UAL74 and AAL12** will arrive at MOD at the same time. **DAL88** will arrive **1 Nmile** behind **AAL12** at MOD. **SWA23** will arrive **1 Nmile** behind **DAL88** at **TPH**. **NWA36** will arrive **1 Nmile** behind **SWA23** at MOD.
- All planes except **UAL74** need to fall back a lot. **AAL12** can either be rerouted or slowed down.

Projected Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	UAL74	33	0
1st	AAL12	33	1
3rd	DAL88	34	1
4th	SWA23	35	1
5th	NWA36	36	



Solution:



- **NWA36 -** Slow down to 420 knots for 3 minutes to fall back 9 Nmiles. Then speed up to 600 knots.
- **SWA23 -** Slow down to 420 knots for 2.4 minutes to fall back 7 Nmiles. Then speed up to 600 knots.
- **DAL88 -** Slow down to 480 knots for 2.5 minutes to fall back 5 Nmiles. Then speed up to 600 knots.
- **AAL12 -** Slow down to 480 knots for 1.5 minutes to fall back 3 Nmiles. Then speed up to 600 knots.

Note: To provide enough time to slow down and speed up so many planes, you need to make greater than typical speed reductions.

- **Target Time** - 4:30 mins.